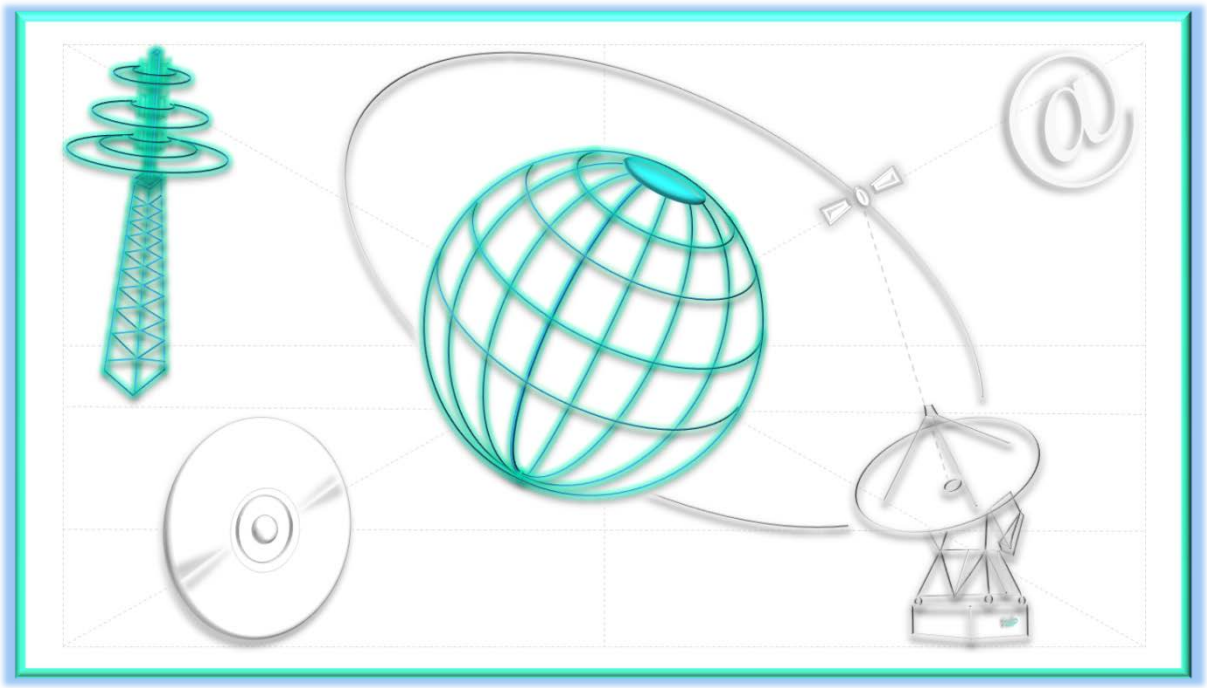
# HD Book
# *DTT platform*

***(Digital Terrestrial Television)***

## Compatible High Definition receivers for the Italian market: baseline requirements



***Final 4.0***

FORUM ITALIA
High Definition and Beyond

CONFINDUSTRIA RADIO TELEVISIONI

# Compatible High Definition receivers for the Italian market: baseline requirements

## DTT platform
*(Digital Terrestrial Television)*

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# 1. Foreword

Since 2005, the High Definition Television formats, 720p and 1080i, have entered the European satellite TV broadcasting market, with a wide offering of tens of HDTV channels provided by different Pay TV aggregators, such as Sky Italy with an offering of HDTV Sport channels.

The Italian Analogue Switch-Off (ASO) process, which started during 2008 in Sardinia, has been completed on July the 4th 2012 in Sicily. Thanks to the new frequencies progressively made available in all-digital areas Italian broadcasters have experienced SD/HD simulcast services, both up-scaled SD contents already available on standard TV transmissions as well as using genuine HD contents.

The vast majority of TV sets currently off the shelf are characterised by screen displays larger than 32 inches, with progressive scanning, panoramic view geometry (16/9) and compatible with HDTV formats and resolutions.

New high-definition audio-visual sources such as media players for home video, BluRay disc players, HDTV and UHDTV cameras, video game consoles, as well as high-definition television programs, are designed to accurately reproduce high-quality contents, when connected to an HDTV display.

In perspective, *"today HDTV is moving to become the standard definition of tomorrow"*. Based on this premise, it is important to continue and to evolve the migration route from SD to HD, aiming to promote the widespread diffusion of free to air HDTV programming. This matches the increased quality of large screen displays and TV sets as well as the increasing demand coming from new experienced customers.

Production and transmission of HD contents has become a need for a successful competitive positioning of Italy in the worldwide digital television market. There is potentially a serious risk of losing relevant market quotes in the promotion of Italian culture, in an industrial context where large European and extra-European entities are rapidly progressing.

Appealing hi-quality content productions, like those necessary for a successful offering of innovative technologies like HDTV, require huge investments. Broadcasters are considering SD/HD simulcasting a viable start towards the complete turnover of SD programmes into HD ones, but they know that a complete refurbishing and reengineering of the entire production, packaging and delivery platform has to occur for a broad diffusion of genuine HDTV services.

In the meanwhile, on one hand new innovative technologies in content definition enhancement, notably the 4K format (UHDTV) which will be increasingly paired with next-generation audio capabilities, are progressively emerging as the new Television benchmark, whilst on the other hand terrestrial spectrum resources devoted to television services are unavoidably going to shrink in the near/mid-term future.

## 1.1. Market outlook

CE industry is particularly committed to boost sales of increasingly larger screen displays in order to maintain a steady cash flow thanks to a constant and rapid renewal cycle of TVs' installed base. For this purpose they undertook, through their major category association in Europe, EICTA (European Industry Consumer Technical Association, now DIGITALEUROPE), the initiative of creating some licensed labels, corresponding to a precise set of technical requirements.

First labels of this kind were launched back in 2005: HD Ready (for TVs) and HDTV (for TVs and STBs) and their counterparts in 1080p format.

***Displays** or **Video Projectors***


***Receivers***


More recently, in 2014, to inform consumers that the display device they are considering buying is compatible with all major sources of Ultra HD content and that it will be able to display this content in Ultra HD format, DIGITAL EUROPE has introduced a new label devoted to Ultra High Definition (3840x2160 pixels) display devices.


The new label timely targets the first generation of UHD displays already available in retail shops. In fact, despite the current very limited availability of UHD contents and services, in the last year UHD displays have literally boomed, moving from niche to mass market products, with prices as low as €1,000.

## 1.2. Technology outlook

As foreseen in the previous release of this document, HD-Book 4.0 marks the introduction of HbbTV middleware, in its most recent 2.0.1 version [6], on the Italian digital television platform as a successor/replacement of MHP.

In the following a few other emerging technologies and standards are introduced that will likely become part of the HD-Book toolbox in future releases.

### *1.2.1. HFR and HDR*

The technological trend for the development of UDHTV format passes through the so-called “UHD-1 Phase 2”, whose exact definition and standardization have just started in DVB. UHD-1 Phase 2 calls for new technologies related to the improvement of television pictures quality not only increasing by 4 times the spatial resolution of HDTV format but also leveraging two additional techniques.

Firstly, by increasing the temporal resolution, e.g. doubling the number of frames per second (HFR, High Frame Rate), so achieving better motion portrayal. Secondly, with the introduction of a significant increase in dynamic range of the luminance variations (HDR, High Dynamic Range).

The use of HFR and HDR, together with the adoption of an extended colour gamut (BT2020 colorimetry), will enhance the TV experience far beyond the current user perception.

A number of activities are taking place in various organizations (SMPTE, ITU, DVB, HDMI, EBU, MPEG) to enable a viable commercial launch of UHDTV Phase 2. It will require a number of changes to occur, involving not only manufacturers but also broadcasters and content providers, who will have to enhance accordingly their own production and delivery chains. Italian broadcasters and content providers are taking steps in this direction.

#### 1.2.1.1. High Frame Rate (HFR)

HDTV format is currently rated to 50/60 fps which are not ideal to guarantee a sufficient definition for fast moving pictures (i.e. Sports). UHDTV resolution is 4 times larger than HDTV and consequently the definition of fast moving pictures become further penalized. HFR technology allows frame rates up to 100 fps, so increasing picture sharpness and stability.

#### 1.2.1.2. High Dynamic Range (HDR)

The dynamic range of a visual system is defined by the ratio of the maximum light intensity to the minimum light intensity [14]. In digital cameras the dynamic range is normally measured in terms of f-stop, which describe the total light range by power of 2. HDR systems typically support a Dynamic Range of more than 10 f-stops, whereas Standard Dynamic Range (SDR) system support up to 10 f-stops. [Ed. note: This definition may be replaced in the future, in case that ITU provides a respective definition.]

Current video distribution environments provide SDR, typically supporting a range of brightness of around 0.1 to 100 cd/m2 (often referred to as “nits”) [17]. Existent consumer displays achieve peak brightness of up to 1000 cd/m2, black levels of below 0,01 cd/m2 and contrast ratios that go far beyond of current specifications. Furthermore the next generation is expected to support even higher values of peak brightness as well as lower values of black levels.

As one of the key goals of Ultra High Definition Television (UHDTV) is to provide the user a sense of “being there” and “reality” [14], it is desired that future transmission standards allow usage of the enhanced display capabilities supporting much higher peak brightness and much larger contrast values than today’s TV. However it is of particular importance that the intent of content creators is maintained over the whole range of displays with different characteristics and capabilities.

### *1.2.2. Improvements in Audio Technologies*

It is important to consider that, for UHD-capable TVs, in particular with support for “UHD-1 Phase 2” features as per above, it is strongly recommended to include next-generation audio codec capability. This can be achieved by including support for AC-4, so far the sole next-generation standardized audio codec. Audio coding and reliability has to achieve comparable enhancements to that which is possible with H.264/AVC and HEVC for enabling the future cost effective roll out of enhanced experiences and services.

HD-Book DTT 3.0 already included a selection of audio codec possibilities together with some usage recommendations, in particular providing guidance for DVB-T2 services when deployed alongside advanced video codecs like H.264/AVC and HEVC. The current document continues these inclusions and recommendations.

However, the currently-specified codecs are at least eight to ten years old, and given that new modern audio codecs have been standardized since the publication of HD-Book DTT 3.0, it is important to start paving the way towards next generation audio features like much improved compression efficiency, better accessibility, dialogue enhancement, intelligent loudness management and new experiences ensured by object-based audio – in particular for UHD-capable TVs.

Despite HD-Book DTT 4.0 primarily addressing Full-HD use cases, it is expected that increasingly UHD-capable TVs will be introduced in the Italian market, potentially with partial or full support for certain so-called “UHD-1 Phase 2” features like HDR and HFR.

Indeed, this document sees UHDTV support for broadband status being elevated from recommended to mandatory. It is therefore important that in the interim transition phase, where we see the increased penetration of UHD-capable TVs ahead of the introduction of the first UHD-specific Book in Italy, good efforts are made to minimize legacy scenarios that would then complicate the roll-out of next-generation future services by the Italian broadcasters.

#### 1.2.2.1. Audio Codec ETSI TS 103 190: AC-4

After the widespread diffusion of AC-3 format and of its successor, EAC-3, the AC-4 audio codec (ETSI TS 103 190) has been designed to go beyond providing simple compression efficiency. In fact AC-4 will enable new, more immersive and personalized consumer audio experiences in the future. Users will be able to hear what the football match sounds like from the stands or the field and experience the kind of sound that transports them right to the centre of the action, whether they are enjoying a game or watching a movie.

Solving several key issues currently facing the industry, the main benefits of AC-4 include:

- Intelligent Loudness: Fully automated loudness management means more precise control and eliminates problems with cascaded processing. It acts across a wide range of devices and applications (home theatre to mobile) and can be configured to align with numerous worldwide standards and/or recommendations.
- Advanced Dialogue Enhancement: End-users can have control of the dialogue level in relation to other sounds in the programme - suiting individual hearing needs and preferences.
- Advanced Accessibility: Service providers can easily and efficiently deliver secondary audio in 5.1 surround sound for the visually impaired without doubling the file size or bitrate.
- A/V Frame Alignment: AC-4 is the first emission audio format that allows the audio frame sizes to precisely match the video frame size. This allows the AC-4 data stream to be edited/spliced at video frame boundaries to maintain synchronization without the need to decode and re-encode the audio.
- Bandwidth Efficiency: AC-4 utilizes state-of-the-art compression techniques that provide significant bandwidth savings or higher quality in stereo and surround sound

AC-4 is standardized in ETSI and Part 1 of the specification is included in the DVB reference specification for audio and video codecs (TS 101 154). AC-4 Part 1 is a channel-based codec which includes coded audio frame alignment with video framing, dialogue enhancement, seamless switching of bitrates and channel configurations, advanced loudness and dynamic range management, additional compression efficiency.

#### 1.2.2.2. Object-based audio

“Objects” in object-based audio could be compared with the individual elements in a conventional mix. On the other hand, the codecs offered for object-based audio include the ability, on the broadcaster’s or the viewer’s part, to put individual audio objects or elements, into specific locations in the sound field, to turn individual audio components on and off, to change their volume levels relative to the other audio components, and, in some cases, to choose between alternate components, such as multiple announcer streams.

If object-based audio would catch on, it could change the technical topography of the living room in much the same way that 5.1 surround did a decade ago. It’s important to distinguish between dynamic object-based audio, where components are constantly moving around, and static object-based audio, where individual objects are in a specific place but can be turned on or off or have their volume or location varied by the viewer.

Object-based audio side products are dialogue enhancement and better delivery efficiency through seamless switching of bitrates for different objects and single transmission with adaptation to the renderer, including evolved loudness and dynamic range management.

## 1.3. Compliance notation

A word on the vocabulary: the use of shall, must, should, may is often baffling for non native English speakers. We have chosen to follow the IETF (Internet Engineering Task Force) which in its RFC 2119 states:

1. MUST: This word, or the terms "REQUIRED" or "SHALL", means that the definition is an absolute requirement of the specification.
2. MUST NOT: This phrase, or the phrase "SHALL NOT", mean that the definition is an absolute prohibition of the specification.
3. SHOULD: This word, or the adjective "RECOMMENDED", means that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
4. SHOULD NOT: This phrase, or the phrase "NOT RECOMMENDED" mean that there may exist valid reasons in particular circumstances when the particular behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour described with this label.
5. MAY: This word, or the adjective "OPTIONAL", means that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. “

N.B. Throughout this document “MANDATORY” is also often used as a “REQUIRED” synonym.

## 1.4. Acknowledgments

The persons that have contributed to the D-Book first and then to the HD-Book DTT are so numerous we would shortly run out of space if we tried to thank them individually. The HDFI / CRTV Joint Technical Group can only extend its gratitude to all of them and repeat that without them, this work could not have been completed. Of course, all errors and omissions are the sole responsibility of the editors and of the HD Forum Italia.

Manufacturers, through their constructive remarks and questions have played a major role in helping us to clarify and improve many points of the specification. Let them be thanked here.

March 2016

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# 2. Document History

| Document | Revision | Changes | Date |
|---|---|---|---|
| HD-Book DTT 1.0 | 0 | Final issue ready for Publishing | 28/10/2008 |
| HD-Book DTT 2.0 | 0 | - EIT schedule requirements cleared up and aligned in Tables 26 and 27<br>- country_availability_descriptor no more required<br>- added note on service_type=0x0<br>- LCN visibility_flag support made mandatory<br>- New requirement on CAM powering off when in stand-by<br>- following AGCOM Deliberation 155/09/CONS, 7MHz Italian channel raster in VHF Band III is no more required<br>- Broadband Interaction channel mandatory also for iDTVs<br>- DGTVi Broadband Addendum merged within sections 6.1.2 and 8.4<br>- New requirement related to application autostart<br>- MMI-MHP interaction scenarios specified<br>- Download CoD OPTIONAL -> RECOMMENDED<br>- EIT schedule compression specified<br>- Download CoD API clarified<br>- Memory requirements in Table 8 clarified<br>- HTTP proxy option added<br>- Removed Resident Broadcaster Defined Applications section<br>- LCN management reviewed (Preference Overflow and Successor Service concepts deleted)<br>- PAE's Pause/Resume controls fixed<br>- Section 5.2 (Broadband Features) imported from HD-Book SAT<br>- New property system.hw.macaddress<br>- error message for broadband apps<br>- corrections and more details to Streamed CoD APIs<br>- custom player creation made RECOMMENDED in 8.4.1.1<br>- SCART in connector for iDTVs made mandatory (as per EC Directive and CCE)<br>- recommended procedures for CI Plus CAM behavior during first installation and reset<br>- .mov extension equated to .mp4<br>- rules for multiple audios over broadband<br>- only 1 HD graphic plane required again<br>- 1080p50 support removed, 1080p25 added<br>- updated references to OIPF R2<br>- OIPF HAS mandatory support added<br>- OIPF generic DRM API support required<br>- Monitoring&Reporting API (Annex K)<br>- explicit support for HTTP REDIRECT added<br>- guidelines for AIT URL (§8.3.6)<br>- correct sequence of embedded and MMI Parental Control messages specified<br>- support for "Frame-Compatible" 3D TV added at decoder, HDMI and signaling level<br>- added OpenGL API requirement<br>- DVB-T2 specified (Sections 6 and 7)<br>- Annex A redefined for DVB-T2 tables<br>- Clarified that AAC-LC is required<br>- MIME-Type for HAS detailed - only MediaLocator can be passed to JMF player<br>- STB -> receiver in §7.5.2<br>- MENU key behavior further specified in §6.4<br>- Prioritization of EIT Schedules (Normal/Compressed) and MHP | 10/01/2011 |

| Document | Revision | Changes | Date |
|---|---|---|---|
| | | view specified<br>- HD graphics requirements clarified (new text and figure)<br>- Updated Streaming monitoring API<br>- Removed MHP as IP media format<br>- Frame-Compatible 3DTV text aligned to DVB<br>- OTT Locator introduced<br>- notes on JMF time, ? in URL and content length added in 8.4.1.1<br>- new org.dvb.user.GeneralPreference “Last Locator” required<br>- §8.6.1 text improved<br>- PP8 applicable only in Single PLP mode<br>- note on service_type=0x00 removed (LCN visibility flag to be used for that purpose)<br>- no root certificates OTA<br>- T2 Noise Figure set to 6dB as per Nordig (former NF Table in Annex A dropped)<br>- New tables in Annex A for C/N Performance, FEF and AUX testing<br>- Warning recommended if service auto update is disabled by user<br>- Reminder section on IXC added<br>- New reqs linked to low-power standby mode<br>- new org.dvb.user.GeneralPreference “IXC” mandated<br>- step-by-step JMF Player start procedure enforced in §8.4.1.1.1<br>- introductory section on 3DTV added (§5.3) pointing to new Annex M for 2D Service Compatible scenarios<br>- minimum input level specified for DVB-T and T2<br>- new introductory section on DRM added (§5.2.3)<br>- §8.4.2 title changed and text reworded<br>- 720p50 Side-by-Side 3DTV format added (broadcast and broadband)<br>- 3D Display STB menu setting added | |
| HD-Book DTT 2.1 | 0 | - Easy-net section removed<br>- Manual setting procedure of IP address fully specified<br>- Recommended IPv6 support<br>- HTTPS streaming specified<br>- MPEG DASH supersedes OIPF HAS for Adaptive Streaming<br>- Reference [54] updated and text aligned accordingly (SEI Information box -> Stereo Video box)<br>- Clarified that DVB Subtitles support is not mandated in case of SbS and T&B TS<br>- Added ADTS support when “self-contained” (raw) audio files are introduced and audio/aac MIME Type to last row in Table 6.<br>- .mov extension support removed<br>- SHALL -> SHOULD for warning message in §6.4 option 2<br>- Historical requirement on APP key added to §6.4<br>- Requirement in §7.5.2 modified to cater for MHP-only services<br>- Parental Control requirements aligned to new AGCOM 220/11/CSP<br>- 960x540 HD Graphics made optional (again)<br>- BAS replaces MHP Security | 19/12/2011 |

| Document | Revision | Changes | Date |
|---|---|---|---|
| HD-Book DTT 2.1 | 1 | - Clarified that LastLocator must refer only to conventional DVB services (no HTTPLocator or AIT file)<br>- Clarified that HTTPLocator doesn't apply to AIT file<br>- Removed requirement on CI Plus Browser contrasting with CIplus C&RR<br>- Optical connector made mandatory for SPDIF<br>- Introduced optional HDMI ARC support<br>- CI Plus reference updated to 1.3<br>- Clarifications and constraints on BAS certificate store added in §9.3.4.2 and §9.4.2<br>- Behavior in case of multiple <AdaptationSet> elements better specified<br>- Reference to OIPF/DTG list of root certificates added in Table 3<br>- Annexes K and L now only reference GEM 1.3 (with clarification on MPEG-7 classification schemes)<br>- Removed any reference to analogue tuner (optional by law since 1/1/2013) and channels<br>- Enforcement for supporting at least 2 service contexts simultaneously active<br>- Exposure of BAS white list requested (§9.4.4 and Annex P)<br>- Linkage between RCMM and BAS white list made explicit<br>- Clarifications on DASH live scenario (Dynamic MPD) added in Annex Q<br>- Decoded PCM multichannel audio added to HDMI audio outputs with related system menu | 30/09/2012 |
| HD-Book DTT 3.0 | 0 | - Provisions hard or impossible to be met removed in §7.3.4.5.3 (Service removal)<br>- Automatic channel update (§7.6.5), previously only recommended, set as mandatory. Removed constraint "the receiver shall start the scanning procedure 1 hour after being put in standby mode". Added clarifications on conflicts handling (pop-up timeout, stand-by case)<br>- Table 34 added to clarify Application manager expected behavior<br>- In case of multiple network interfaces (e.g. Ethernet and WiFi), system.hw.macaddress property shall expose the currently active one.<br>- Clarified that In case of DASH contents, languages defined at MPD level must be taken into account for controls provided by org.davic.media.LanguageControl<br>only if language information is missing at container level.<br>- New section 9.3.5 dealing with impact of BAS on broadcast applications<br>- Clarified in §9.3.4 that any GEM resource which is neither basic, nor system, nor private, shall be accessible by any BAS-compliant or non BAS-compliant application without the need of any PRF or certificate.<br>- Option of certificates bound to one or more particular application introduced in §9.3.4 but left platform-dependent.<br>- Sections A.2.1 and A.2.2 renamed<br>- Ordering of representations returned by VideoStreamQualityInfo specified in Annex K<br>- New sections 6.2.9 and 6.3.5, dealing with Player Pad added<br>- Table 14 revised to include clarifications/requirements on certain keys' behaviour during playback of broadband contents<br>- Support for MPEG DASH MPEG2-TS Simple Profile removed.<br>- Support for DVB-DASH Profile added. As a consequence previous profiling reqs in §6.1.2.1 have been marked as RECOMMENDED.<br>- Support for EBU-TT-D Subtitles added in Table 4, §6.1.2.1 and §8.4.1.1.5<br>- iDTV SCART input and STB Output RF connectors downgraded to OPTIONAL<br>- T2 reference updated to version 1.4.1 and reference to | |

| Document | Revision | Changes | Date |
|---|---|---|---|
| | | DIGITALEUROPE T2 white paper added<br>- Updated rederence [8] to IEC 62216<br>- CAD support added (§6.1.2.1, §8.4.1.1, §8.4.1.1.5 and §8.4.1.2) for broadband parental control and playlists<br>- T2 profile revised (PP8 support dropped, resistance to interference row added, NF revised and extended to multi tuner case, new C/N Performance table<br>- Reference to CIPlus updated to version 1.3.1<br>- CICAM section (§9.1.3) extensively reviewed.<br>- Historical Annex G dropped with still valid points moved to §9.1.3<br>- Historical Annexes C and D removed<br>- Requirements for H.264/AVC broadcast and broadband profiles rewritten in terms of conformance points<br>- HEVC support introduced:<br>- References [8][9] and [10] updated and [74] added<br>- HEVC Main 10 Profile @ up to Level 4.1 support mandated for broadcast and broadband profiles<br>- HEVC Main 10 Profile @ up to Level 5.1 support recommended for broadband profile on UHD receivers, with specific maximum bit rate values<br>- PSI and SI text added for HEVC in §7.2.2.2 and §7.2.5.1<br>- HEVC compatibility points added to Table 37 (CENC)- HEVC signalling in §7.2.5.1 aligned to final DVB version, specifying that service_type 0x01 is not allowed for HEVC services<br>- Removed any reference to maximum bit rate for UHD contents streamed over HTTPS.<br>- Added “UHD Receiver” definition in §4<br>- Same text as for SD -> HD graphics scaling added for SD/HD -> UHD graphics scaling in §8.3.5<br>- In order to maintain historical embedding of D-Book (SD) specs within HD-Book, MHP 1.0.3 and 1.1.3 are both mentioned and referenced<br>- UHDTV DVB naming adopted instead of “UHD-1 Phase 1”<br>- Delivery of EBU-TT-D subtitles as a separate document in a single file is not supported at this stage.<br>- DIGITAL EUROPE HDMI/HDCP requirements for UHD receivers endorsed<br>- Added notes in Table 1 on obsolesce of MPEG-1 L2 Audio and on EAC-3 embedding AC-3<br>- AC-3 removed from Table 5 and 37<br>- Added note in Table 5 on obsolesce of MPEG-1 L2 Audio<br>- New references to Nordig, EBU and DIGITAL EUROPE documents on DVB-T/T2 front-end<br>- DVB-T NF changed to 7dB (8dB for multiple tuners)<br>- Minimum DVB-T input level updated with Annex C reused for new data<br>- Table 1 rows on interference refined and extended to LTE case for both DVB-T and DVB-T2<br>- New note on FEF and Auxiliary Streams<br>- Handling of T2-Lite signal specified<br>- Sections A.2 extensively revised with new tables on T2 C/N performance<br>- Update of service name and LCN during automatic scan added in section 7.6.5<br>- Chapters 1 and 5 revised altogether<br>- Forgotten “UHD-1 Phase 1” changed to “UHDTV”<br>- References to HDMI 2.0 and HDCP 2.2 added for UHD receivers<br>- SCART connector made OPTIONAL for UHD STB receivers<br>- Clarifications on HDMI/HDCP output for UHD STBs added<br>- Improved definition of “UHD Receiver”<br>- Updated IEC references for RF connectors | |

| Document | Revision | Changes | Date |
|---|---|---|---|
| | | - 1080p50 set as new default HDMI output format for STBs<br>- Section 1.1 revised and smoothed by HDFI Board<br>- Added icons in Table 15<br>- New HEVC system property introduced in §8.3.4<br>- HDFI logo updated | |
| HD-Book DTT 4.0 | 0 | - Reference to Delibera 216/00/CONS updated to 685/15/CONS and extended to relevant T2 parameters<br>- S/PDIF downgraded to OPTIONAL<br>- HDMI ARC made MANDATORY unless S/PDIF is present<br>- DASH support aligned to DVB-DASH and HbbTV 2.0.1 profiles<br>- SSU section rewritten with OTN update added<br>- New text in Chapter 1 for HFR and HDR<br>- 1080p25 AVC encoded and 2 UHD sub-resolutions added for OTT<br>- EITschedule compression removed from Chapter 7 and Annex J<br>- Chapter 8 and 9 swapped and extensively revised (MHP removal and HbbTV introduction, CIPlus 1.4.1 support)<br>- Annex B dropped<br>- AFD section moved to Chapter 6<br>- Linear IP services introduced. Chapter 7 extensively revised accordingly<br>- Removed any reference to EACEM_stream_identifier_descriptor<br>- CICAM applicability extended to STBs as an alternate option to embedded CA<br>- Function of BACK and EXIT keys revised in Table 8<br>- 3D support extended to HEVC<br>- Standard DVB service replacement feature added/enforced<br>- Annexes reordered after removal of several Voids<br>- Reference to SI split in two (last published version of ETSI EN 300 468 and BlueBook with next one)<br>- Duplicated section on “Service variation options” removed<br>- 3DTV disclaimer added in Chapter 5 after 7/4 HDFI Steering Board | |

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# 3. References

For the purposes of this HD-Book, the following references apply:


[1] "Easy TV" Research Report, ITC 2003, and PsychNology Journal, 2003, Volume 1, Number 4, 355 – 377, "Helping Viewers Press the Right Buttons: Generating Intuitive Labels for Digital Terrestrial TV remote controls", Jane Lessiter, Jonathan Freeman, Robert Davis and Andrew Dumbreck

[2] AGCOM Delibera n. 685/15/CONS: "Modifiche alla determinazione degli standard dei decodificatori e le norme per la ricezione dei programmi televisivi ad accesso condizionato di cui alla Delibera 216/00/CONS"

[3] CEI - Comitato Elettrotecnico Italiano, Comitato Tecnico 100, "Guida alla tecnologia e ai servizi dei ricevitori (Set Top Box e televisori digitali integrati) per la televisione digitale terrestre", Progetto di Guida, 03/06/2003

[4] CENELEC EN 500 74 "Domestic and similar electronic equipment interconnection requirements: Peritelevision connector"

[5] Digital TV Group: "Baseline functional specification for DTT receivers for the UK" (D-Book)

[6] HbbTV Association: "Hybrid Broadcast Broadband TV" version 2.0.1 (2016)

[7] EBU Recommendation R-110-2004 on "Subtitling on Digital TV Services

[8] IEC 62216:2009 "Digital terrestrial television receivers for the DVB-T system"

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# 4. Definitions and abbreviations

## 4.1. Definitions

**3D Receiver**: either a TV set capable of decoding 3DTV signals specified in this document and used as receiver or a STB capable of decoding 3DTV signals specified in this document and of driving a 3DTV display.

***3DTV "Frame-Compatible" Mode:*** a frame-compatible 3DTV format is one that carries separate left and right video signals within the video frame used to convey a conventional 2D high-definition signal by squeezing them to fit within the space of one picture.

***3DTV "Service-Compatible" Mode:*** in service-compatible 3DTV transmissions a regular 2D high definition signal is broadcasted to all viewers, while additional data are sent to complete the picture for those homes with a 3D display.

***3DTV "Service Frame Compatible" Mode:*** a service frame compatible 3DTV format is a Frame-Compatible one where signalling is provided in the coded video bit-stream enabling existing HDTV receivers to extract the left view from the two views contained in the frame compatible video stream and up-scale it to simulate the reception of an HDTV service.

***Adaptive Streaming:*** a technique, used in the context of OTTV to cope with Open Internet varying throughput conditions, where more files corresponding to encodings at different bit rates of the same content which the receiver can seamlessly switch to are made available by the Service Provider.

***Application Service Provider:*** an entity that manages and distributes applications and services for interactive television to customers (i.e. broadcasters and consumers) from a central data center. This entity may also provide interaction channel processing services.

***Cross carriage:*** Carrying the data (typically EIT data) pertaining to one multiplex on a different multiplex. Cross carriage agreements usually imply reciprocity.

***Interaction Channel***: a bi-directional link connecting the Receiver to a Server for providing extra functionality, such as personalized data, billing, e-commerce, etc. Often called return channel.

***License:*** An object that governs the use of Content and specifies the conditions for allowing access to the Content Key used to encrypt the Content.

***Locator:*** The unique identifier of a DVB service/event.

***Out of Box Experience:*** the first contact of the user with the product, as experienced when taking it out of the packaging box and plugging it into the wall socket and antenna cable (without having to read tons of manuals…).

***Over-The-Top Services:*** A general term for video services delivered over the Open Internet. It's referred to as "over-the-top" because these services ride on top of plain Internet access service and don't require any business or technology affiliations with the network operator.

***Receiver:*** a piece of equipment designed to receive (and decode) DTTV signal. It can be provided as a separate box – in this case it is often called Set Top Box (STB), and sometimes Integrated Receiver Decoder (IRD) – or can be incorporated into a TV set, which is then called an Integrated Digital TV set (iDTV).

***Service:*** For TV and Radio, a sequence of programmes under the control of a broadcaster which can be broadcast as part of a schedule [10]. For Applications and Data, refers to a data stream that can be used directly or be presented to an output interface, without having to tune into a TV or Radio service.

***Service List:*** List of all autonomously accessible services (television, radio, application, and data) identified through a service number

***Plano-stereoscopic TV:*** First Generation 3DTV systems are sometimes called 'Plano-stereoscopic TV' because the underlying characteristic of these systems is that they

carry two channels, for viewing by the left and right eye (L and R). These systems usually require the viewer to wear glasses for large screen viewing.

***TV Viewing Mode or Viewing Mode***: normal TV viewing condition, when less than 5% of the screen area is covered by any HbbTV, or receiver proprietary, GUI.

**UHD Receiver**: either a TV set with UHD resolution capable of decoding UHD signals specified in this document and used as receiver or a STB capable of decoding UHD signals specified in this document and of driving a display with UHD resolution.

## 4.2. Abbreviations

| | |
|---|---|
| 3DTV | Plano-stereoscopic 3D TV |
| AAC | Advanced Audio Coding |
| AAC-LC | AAC Low Complexity |
| AC-3 | Audio Coding 3 |
| AC-4 | Audio Coding 4 |
| ACE | Active Constellation Extension |
| ADSL | Asymmetric Digital Subscriber Line |
| ADTS | Audio Data Transport Stream |
| AES | Advanced Encryption Standard |
| AFD | Active Format Descriptor |
| AGCOM | Autorità per le Garanzie nelle Comunicazioni |
| AIT | Application Information Table |
| API | Application Programming Interface |
| AVC | Advanced Video Coding |
| BAT | Bouquet Association Table |
| BER | Bit Error Rate |
| BW | Band Width |
| CA | Certification Authority |
| CA | Conditional Access |
| CAD | Content Access Descriptor |
| CAM | Conditional Access Module |
| CENC | Common Encryption |
| CHAP | Challenge Handshake Authentication Protocol |
| CI | DVB Common Interface |
| CICAM | CI CAM |
| CoD | Content on Demand |
| COFDM | Coded Orthogonal Frequency Division Multiplexing |
| CRL | Certificate Revocation List |
| CRTV | Confindustria Radio TV |
| CVBS | Component Video Baseband Signal |
| DAB | Digital Audio Broadcasting |
| DAE | Declarative Application Environment |
| DASH | Dynamic Adaptive Streaming over HTTP |
| DHCP | Dynamic Host Configuration Protocol |
| DRM | Digital Rights Management |
| DTS | Digital Theater Systems |
| DTT(V) | Digital Terrestrial Television |
| DTV | Digital Television |
| DVB | Digital Video Broadcasting |
| DVB-H | DVB Handheld |
| DVB-T | DVB Terrestrial |
| EACEM | European Association of Consumer Electronics Manufacturer |
| EDID | Extended Display Identification Data |
| EHDF | European HD Forum |
| EICTA | European Information and Communication Technology Association |

| | |
|---|---|
| EIT | Event Information Table |
| EPG | Electronic Program Guide |
| ETSI | European Telecommunications Standards Institute |
| EU | European Union |
| FEF | Future Extension Frame |
| FIFO | First In First Out |
| FFT | Fast Fourier Transform |
| FTTH | Fiber To The Home |
| GPRS | General Packet Radio System |
| GS | Generic Stream |
| GUI | Graphic User Interface |
| HbbTV | Hybrid broadcast broadband TV |
| HD | High Definition |
| HDCP | High bandwidth Digital Copy Protection |
| HDFI | HD Forum Italia |
| HDMI | High Definition Multimedia Interface |
| HDSPA | High-Speed Downlink Packet Access |
| HDTV | High Definition TV |
| HE-AAC | High Efficiency AAC |
| HEVC | High Efficiency Video Coding |
| HTTP | Hyper-Text Transfer Protocol |
| HTTPS | Hyper-Text Transfer Protocol Secure |
| iDTV | Integrated Digital TV Set |
| IP | Internet Protocol |
| IPTV | IP Television |
| IRD | Integrated Receiver Decoder |
| ISO | International Organization for Standardization |
| ISOBMFF | ISO Base Media File Format |
| ISP | Internet Service Provider |
| i-TV | Interactive Television |
| LAN | Local Access Network |
| LTE | Long Term Evolution |
| MFN | Multi Frequency Network |
| MHP | Multimedia Home Platform |
| MIME | Multipurpose Internet Mail Extensions |
| MPD | Media Presentation Description |
| MPEG | Moving Picture Experts Group |
| NID | Network ID |
| NIT | Network Information Table |
| NTS | Network Time-Shift |
| OCSP | Online Certificate Status Protocol |
| OFDM | Orthogonal Frequency Division Multiplexing |
| OIPF | Open IPTV Forum |
| OMA | Open Mobile Alliance |
| ONID | Original Network ID |
| OSD | On-Screen Display |
| OSDT | Online SDT |
| OTA | Over The Air |
| OTT-TV | Over The Top TV |
| PAE | Procedural Application Environment |
| PAL | Phase Alternate Lock |
| PAP | PPP Authentication Protocol |
| PAPR | Peak-to-Average Power Ratio |
| PAT | Program Association Table |
| PCMCIA | Personal Computer Memory Card International Association |

| | |
|---|---|
| PDC | Program Delivery Control |
| PID | Packet IDentifier |
| PKI | Public Key Infrastructure |
| PLP | Physical Layer Pipe |
| PMT | Program Map Table |
| POP | Point Of Presence |
| PPP | Point-to-Point Protocol |
| PPPoE | PPP over Ethernet |
| PRF | Permission Request File |
| PSI | Program Specific Information |
| PSTN | Public Switched Telephone Network |
| QAM | Quadrature Amplitude Modulation |
| QEF | Quasi Error-Free |
| QPSK | Quadrature Phase Shift Keying |
| RCMM | Root Certificate Management Message |
| RRC | Regional Radio Conference |
| RSA | Rivest, Shamir, Adleman |
| SCART | Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs |
| SD | Standard Definition |
| SDT | Service Description Table |
| SEI | Supplemental Enhancement Information |
| SFN | Single Frequency Network |
| SI | Service Information |
| SID | Service ID |
| SIM | Security Identity Module |
| SSU | System Software Update |
| STB | Set Top Box |
| T-DMB | Terrestrial Digital Media Broadcasting |
| T2-IRD | DVB-T2 Integrated Receiver Decoder |
| TLS | Transport Layer Security |
| TM | DVB Technical Module |
| TFS | Time Frequency Slicing |
| TR | Tone Reservation |
| TS | Transport Stream |
| TSID | Transport Stream ID |
| UHD(TV) | Ultra High Definition (TV) |
| UHF | Ultra High Frequency |
| UI | User Interface |
| UNT | Update Notification Table |
| URL | Uniform Resource Locator |
| USB | Universal Serial Bus |
| VHF | Very High Frequency |
| WAN | Wide-area Access Network |
| WLAN | Wireless LAN |
| WSS | Wide-Screen Signalling |

# 5. The HD-Books

HD-Books are a collection of technical specifications aimed to manufacturers of television receivers (STB and TV). It sets out the baseline requirements for the Italian digital television platform: open, horizontal, interoperable, hybrid. The HD-Book Collection, born in 2008, consists of specific HD-Book volumes, dedicated to the different distribution platforms: DTT (Digital Terrestrial Television), SAT (Open Satellite) and OTT (Over the Top). The HD-Book Collection is published by HD Forum Italia, in collaboration with the other stakeholders of the Italian digital television platform: CRTV (Confindustria Radio Televisioni) and Tivùsat.

HD Forum Italia (HDFI) is an association constituted on September 19th. 2006, to represent the general interests of the industry and consumers towards high definition. HDFI is aimed to promote, support, illustrate and disseminate the utilization of multimedia contents and audiovisual programmes, productions and technology in high definition format (HD) and beyond (3DTV, UHDTV).

The HDFI association members represent the major institution & companies in the audiovisual & telecommunication Industry in Italy. They cover most segments of the entire production chain, from the content creations to end users: Azienda Autonoma di Stato per i Servizi Pubblici (Republic of San Marino), Archimedia, Dolby, Eurofins, Eutelsat, Fastweb, Fondazione Ugo Bordoni, LG, Lutech, Mediaset, Panasonic, Persidera, Piksel, RAI, Samsung, SES Astra, Sisvel Technology, Sky Italia, Sony, STMicroelectronics, Telecom Italia, Tivù, TP Vision and Vesit.

HDFI adheres, as Italian member organization, to FAME (Forum on Advanced Media in Europe, formerly known as EHDF, European HD Forum), promoted and jointly chaired by the international organizations EBU (European Broadcasting Union) and DIF (Digital Interoperability Forum.

DGTVi has been the association which has represented the general interests of the Italian DTT industry until ASO completion on June 2012. Since June 2013 DGTVi role has been taken over and widened in scope by Confindustria Radio Televisioni (CRTV) which now represents the general interests of the whole Italian broadcasting industry (TV, Radio, DTT, SAT).

This document describes the **baseline requirements** that are needed for a HDTV DTT receiver with broadband connectivity to claim compatibility with joint HDFI/CRTV specifications.

The first baseline specification was finalized by DGTVi in September 2004 under the name of “D-Book, Compatible DTTV receivers for the Italian market” (v1.0). This specification was later updated with different stand-alone addenda. The “D-Book 1.2” merged all these addenda in a single clean document which took into account the comments received by the industry.

The D-Book 1.2 has been the basis on which HD-Book DTT 1.0 was jointly developed in 2008 by HDFI and CRTV, by introducing all HD-specific features (formats, codecs, connectors, signalling, simulcasting). At the same time, latest developments in the areas of supplementary audio and of automatic channel ordering (LCN) to cope with cross-border conflicts were taken into account. Such developments were then incorporated in D-Book 1.3.

Besides applying all the necessary corrigenda to HD-Book DTT 1.0, its 2.0 successor merged the so-called “Broadband Addendum” which had been developed by DGTVi in the

second half of 2009, after HD-Book DTT 1.0 was published, to complement it in the area of media delivery over broadband (IP) lines.

The 2.x versions of HD-Book DTT brought new advanced features to the Italian DTT platform, like DVB-T2, first generation (Frame Compatible) 3DTV and broadband enhancements (e.g. Adaptive Streaming, Broadband Applications Security and generic DRM support).

The HD-Book DTT 3.0 baseline requirements have fostered the introduction of top quality services (Full HD 1080p50 and UHD 2160p50) based on most advanced video compression standards (HEVC), in order to achieve maximum efficiency in spectrum utilization

In particular, as everybody agrees that the driving force for first generation UHDTV will be OTT while it might take much more time for seeing it on DTT (especially in Italy), within HD-Book DTT 3.0 UHDTV support has been specified only on the broadband side. This cautious approach is confirmed in the present document.

Key new features of this HD-Book DTT 4.0 are:

- HbbTV 2.0.1 middleware replacing MHP
- Support of CIPlus 1.4.1
- Introduction of linear IP services
- 3DTV support for HEVC

Regarding the last bullet, it must be noted that the whole 3DTV subject is going to be revisited, both from commercial and technical point of view, in the next HD-Book release.

Special attention has been paid to the needs of impaired people through some ancillary requirements specifically devoted to them. The following symbols are used by European broadcasters to mark transmissions offering audio description or video subtitling services.

Some optional features are also described that allow compatibility with the innovative services being introduced on the digital TV networks.

## 5.1. Terminology and notation

The features are divided into two main categories: *“mandatory”* and “*optional”*.

When a feature is “mandatory”, its inclusion is mandatory and it must conform to the defined specification.
When a feature is “optional”, its inclusion is left at the choice of the manufacturer, but whenever implemented, it shall be implemented in conformance with the specification.
Within the optional category, the document presents some features, which would be of a great advantage to the user, as “recommended”.

Features or requirements which apply only to either STBs or iDTVs are clearly highlighted both in the text and in visual form, namely:

Refers to a feature or a section applicable only to iDTVs (yellow marker)

Refers to a feature or a section applicable only to STBs (light blue marker)

*Refers to an HD-specific feature* (italic)

*The different TV formats are represented in the document according to the following notation [41]:*

*<active lines> <scanning> <frames/s>*

*For instance:*
*576i25 (aka 576@50i) represents the 720x576 interlaced format in 50Hz systems*
*720p50 (aka 720@50p) represents the 1280x720 progressive format in 50Hz systems*
*1080i25 (aka 1080@50i) represents the 1920x1080 interlaced format in 50Hz systems*

## 5.2. Linkage with other organizations

Where available and compatible with the Italian situation, the specification contained in this document refers to standards developed by standards setting organisations (DVB, ETSI, DIGITALEUROPE, NorDig, MPEG, OIPF, ISO, CEI, CEN). Furthermore, it follows the Italian legislation in force concerning DTT and reception equipment for Digital Terrestrial Television [2].

For the aspects of the receiver where nothing is indicated, the expectation is that manufacturers will follow the EICTA E-book. The version 2.0 is taken as a reference (with the exception of obvious editorial errors).

However, the HD-Book DTT does not endorse the E-Book specifications concerning the transmitted signal (which principally concerns networks operators and not receiver manufacturers) and expects that receivers shall be compatible with all DVB legal configurations and signalling. This is to great extent due to the fact that the E-Book is not adapted to the specific structure of digital terrestrial broadcasting in Italy.

## 5.3. Graceful Degradation

A receiver compliant with this specification shall implement a “graceful degradation” mechanism for specific unsupported (optional) features and shall behave as follows:

- the receiver shall not unexpectedly terminate the current runtime application
- the receiver shall not hang up
- the user shall be unaware of any exception thrown by the middleware (for applications conforming to the HbbTV specification), but shall be informed of the unavailability of the requested service or functionality on the receiver.

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# 6. Basic requirements

## 6.1. Terrestrial Front End & Signal Decoding

The Italian DTT network is still evolving. Receivers must support a range of transmission parameters and modes to allow for changes in the use of the allocated spectrum.

Receivers MUST meet minimum performance criteria to maximise both network coverage and the reliability of receivers acquired by consumers in the retail market.

The receiver SHALL support the signal characteristics specified in the following.

*A receiver capable of receiving DVB-T2 broadcasts [47] SHALL also be capable of receiving DVB-T broadcasts [13]. Such a receiver is in the following referred to as "T2-IRD", when there is a need to differentiate such a receiver from a receiver supporting DVB-T only. The T2-IRD shall automatically detect whether DVB-T or DVB-T2 signal is being used in the specific channel.*

| Feature | Specification | Comment |
|---|---|---|
| **DVB-T** | | |
| Channel Bandwidth | - 7 MHz in Band III (European VHF channel allocation)<br>- 8 MHz in Band IV-V (UHF) | Ref. : [2]<br><br>Since July 2009, according to resolutions taken at Regional Radio Conference GE06, Italy has adopted 7MHz bandwidth in Band III with European channel allocation [32] |
| Digital demodulation | COFDM DVB-T (EN 300 744) | Ref. : [2] |
| Transmission mode | 2k and 8k | Ref.: [2] |
| Constellation Combinations | QPSK, 16-QAM, 64-QAM, hierarchical 16-QAM, hierarchical 64-QAM) | Ref.: [2] |
| Code rates | 1/2, 2/3,3/4, 5/6 or 7/8 | Ref.: [2] |
| Guard Interval | 1/4, 1/8, 1/16 or 1/32 | Ref.: [2] |
| Hierarchical Modulation | Alpha=1, 2 or 4 (where applicable) | The receiver is required to demodulate and present all and only the services that it is able to handle among those possibly available in both high (HP) and low priority (LP) streams. Ref.: [13] |
| Noise Figure (NF) | Better than 7 dB<br><br>Note: for dual or multiple internal tuners a NF better than 8 dB is highly recommended for implementation. | Ref.: [56] [28]<br><br>Same as §12.7.3 in E-Book [8].<br>1 dB better than in [2]. |
| Implementation Margin | Better than 3 dB. | Ref.: [2] |

| Feature | Specification | Comment |
|---|---|---|
| Minimum signal level | The demodulator operates on Gaussian channel at QEF performance (i.e. BER less than $2x10^{-4}$ after convolutional decoding and before Reed-Solomon decoding) with a minimum input signal of -78.2dBm across the whole UHF range (8k, 64 QAM mode, 2/3 code rate, Tg/Tu ¼, 8dB NF and 7.61MHz bandwidth). | Ref.: [2] [77], [78].<br><br>See Annex B.<br><br>The value -78.2 dBm is the value mandated in [2], under the main hypothesis of NF=8 dB. |
| Maximum Signal Level | Greater than -28 dBm (80 dBµV on 75 Ohm) without degrading the signal (Implementation Margin). | Even with a strong reduction in the power transmitted, in the hypothesis of an antenna gain of 12 dB and a cable loss of 4 dB there could be levels reaching the receiver of -35dBm (73 dBµV on 75 ohm) and of the order of -25, -30 dBm.<br>The deliberation of AGCOM reports: "The front end must operate with an over-specified Implementation Margin [note of the editor: equivalent to 3dB] with maximum signal of -35dBm."<br>Ref.: [2] |
| Resistance to interference (analogue and digital) co-channel, on adjacent channel and from LTE signals in 800 MHz Band. | Reference values on resistance to interference (analogue and digital) from other channels are contained in [2].<br><br>Reference on resistance to interference from LTE signals in 800 MHz Band is the NorDig Unified ver. 2.5.1, chapter 3.4.10.6.2 "Immunity to 800 MHz LTE signals in other channels" [78]. | It's expected that the DVB-T receiver permits an interfering DVB-T/T2 signal with (minimum) interference to signal level ratio (I/C) of 38 dB when the interference is on +/-2 channels (Band IV and V UHF, 8MHz BW), while maintaining QEF reception for DVB-T modes 64QAM, GI 1/4, code 2/3 and 3/4. See also [78], paragraph 3.4.10.6.1 and Table 3.16. |
| Behaviour in the presence of two static (distant) echoes | The receiver correctly operates in the presence of two static echoes (i.e. 2 paths) with a relative delay in a range of 0,2 µs. and 0,9 times the duration of the guard interval, independently of the value of the amplitude and of the relative phases. This requirement applies to all possible modes. | This is the minimum requirement if one wants the receiver to also operate in a Single Frequency Network as well.<br>The minimum performance and test profile are those presented in E-Book [8], §12.7.8.1 |
| Behaviour in the presence of short echoes | In the presence of echoes of matching levels, the demodulator operates with an implementation margin of 3.5 dB when the channel profile corresponds to that reported in EN 300 744 [13] (Rice and Rayleigh profiles using the six strongest rays). In the presence of an echo at 0 dB, in the absence of noise, to the limit of the guard interval, and for any guard interval, the demodulator operates with QEF performance in the 64 QAM mode and with 2/3 code rate. | Ref: [13] [2]<br><br>The minimum performance and test profile are those presented in E-Book [8], §12.7.8.2 |
| Change of modulation parameters | At least code rate, time guard and constellation changes shall be automatically detected | Network(s) evolution shouldn't impact existing services |
| Demultiplexing | MPEG-2 System Transport Stream | Ref.: [9] |

| Feature | Specification | Comment |
|---|---|---|
| **DVB-T2** | | |
| Channel Bandwidth | - 1.7 MHz (OPTIONAL)<br>- 7 MHz (European VHF channel allocation) in Band III<br>- 8 MHz in Band IV-V (UHF) | Since July 2009, according to resolutions taken at Regional Radio Conference GE06, Italy has adopted 7MHz bandwidth in Band III with European cannel allocation [32] [2] |
| Digital demodulation | COFDM DVB-T2 | Ref. : [47] [2] |
| Transmission mode | 1K, 2K, 4K, 8K normal and extended, 16K normal and extended, 32K normal and extended | Ref.: [47] [2]<br>- For 8 MHz DVB-T2 signal, a normal carrier mode corresponds to a signal bandwidth of 7.61 MHz and an extended carrier mode corresponds to a signal bandwidth of 7.71 MHz for FFT size of 8K and 7.77 MHz for FFT size of 16K and 32K.<br>- For 7MHz DVB-T2 signal, a normal carrier mode corresponds to a signal bandwidth of 6.66 MHz and an extended carrier mode corresponds to a signal bandwidth of 6.80 MHz.<br>- For 1.7 MHz DVB-T2 signal, a normal carrier mode corresponds to a signal bandwidth 1.54 MHz and an extended carrier mode corresponds to a signal bandwidth of 1.57 MHz |
| Constellation Combinations | QPSK, 16-QAM, 64-QAM, 256-QAM, both rotated and non-rotated | Ref.: [47] [2] |
| FEC Frame length | 64800, 16200 | Ref.: [47] [2] |
| Code rates | 1/2, 3/5, 2/3, 3/4, 4/5, 5/6 | Ref.: [47] [2] |
| Pilot pattern | PP1, PP2, PP3, PP4, PP5, PP6, PP7 | Ref.: [47] [2] |
| Guard Interval | 1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4 | Ref.: [47] [2] |
| Single/Multiple PLP | Both | The receiver is required to demodulate and present all and only the services that it is able to handle among those possibly available.<br>Input Mode A (single PLP) or Input Mode B (Multiple PLPs – Common PLP, Type 1 and 2 up to the maximum allowed figure 255)<br>Ref.: [47] [2] |
| Time interleaving | $2^{19}+2^{15}$ OFDM cells for a data PLP and its common PLP together | Ref.: [47] [2] |

| Feature | Specification | Comment |
|---|---|---|
| PAPR | All possible configurations:<br>- No PAPR<br>- ACE-PAPR only<br>- TR-PAPR only<br>- both ACE and TR | Ref.: [47] [2] |
| SISO/MISO | Both | Ref.: [47] [2] |
| Time Frequency Slicing (TFS) | Not required | Ref.: [47] [2] |
| FEF parts and Auxiliary streams | The receivers are not required to demodulate or decode the content of FEF parts and auxiliary streams, but the existence of FEFs and/or auxiliary streams shall not cause receiver to malfunction.<br><br>Receivers are required to ignore the possible presence of a T2-TX-SIG signal. | Ref.: [47] [2]<br><br>See Annex A.<br><br>Note: The 'auxiliary-stream" and the 'FEF' methods described in [75] are complementary and may, if desired, be used in combination. |
| T2-Lite | The receivers are not required to demodulate or decode the content of T2-Lite signals, but the existence of T2-Lite signals shall not cause the receiver to malfunction.<br><br>Receivers are required to ignore the possible contemporary presence of a T2-Lite and a T2-TX-SIG signal.<br><br>Optionally, the receiver can also demodulate and present the list of available T2-Lite services. For this feature:<br>• The characteristic of the T2-Lite signals shall comply with [47] and [48], including all the limitations in terms of Modulation, Mode, PLP data rate and T2-Lite receiver buffer model.<br>• Only the T2-Lite signals that use one of the T2-Base code-rates (1/2, 3/5, 2/3, 3/4, 4/5, 5/6) are considered. The case of T2-Lite signals that use the T2-Lite additional code-rate "1/3" or "2/5" is out of scope. | Ref.: [47][48][75]<br><br>See Annex A.<br><br>Note:<br>• T2-Lite signals can be transmitted as "stand alone" signals i.e. in a multiplex dedicated to T2-Lite.<br>• For the combination of T2-Lite and T2-Base in the same multiplex, T2-Lite is transmitted in the FEF of T2-Base and vice versa.<br>• Alternatively the content of the above "T2-Lite services" can be transmitted in a separate PLP to the above "T2-Base services" but this PLP is subject to the range and limitations of the range of modcod parameters available to the T2-base transmission. The same FFT size and guard interval must be used for both PLPs and the "1/3" and "2/5" T2-lite code rates cannot be used. In this case no FEF mechanism is required. |
| Resistance to interference (analogue and digital) co-channel,on adjacent channel and from LTE signals in 800 MHz Band. | See Annex A | Ref.: [56][78] |
| Noise Figure (NF) | Better than 6dB<br><br>Note: for dual or multiple internal tuners a NF better than 7 dB is highly recommended for implementation | Ref.: [28] [78] |
| C/N Performance | See Annex A | |

| Feature | Specification | Comment |
|---|---|---|
| Minimum signal level | The receiver SHALL provide QEF reception for the following minimum signal levels ($P_{min}$):<br><br>For 7MHz Normal/Extended Bandwidth:<br>$P_{min}$ = -105.7dBm + NF [dB] + C/N [dB]<br>For 8MHz Normal Bandwidth:<br>$P_{min}$ = -105.2dBm + NF [dB] + C/N [dB]<br>For 8MHz Extended Bandwidth:<br>$P_{min}$ = -105.1dBm + NF [dB] + C/N [dB] | [78] with C/N values given in Annex A |
| Demultiplexing | MPEG-2 System Transport Stream | Ref.: [9] |
| **A/V Decoding** | | |
| *Audio Decoder (SD and HD modes)* | The following standards SHALL be supported:<br>- MPEG-1 Audio Layer I & II [2]<br>- *HE-AACv1 up to level 2 for stereo and level 4 for multichannel (5.1)*<br>- AC-3 (aka Dolby Digital)<br>- *Enhanced AC-3 (aka Dolby Digital Plus) up to 5.1 channels* [3]<br><br>Receivers SHALL support audio description in the following formats as per [10]:<br>- MPEG-1 L2 broadcaster mix<br>- MPEG-1 L2 receiver mix<br>*- HE-AACv1 and Enhanced AC3 receiver mix*<br>Receivers MAY support other modes of audio description.<br>Receiver MAY support "clean-audio" in broadcaster-mix format. | *Ref.: [9]*<br>Full decoding of stereo transmissions is mandatory for any of the standards listed aside.<br><br>*PCM Stereo downmix of 5.1HE-AACv1, AC-3 or Enhanced AC-3 transmissions is mandatory. Presentation of the downmixed analog signal on SCART and RCA outputs (if present) is mandatory.*<br><br>*Transcoding of 5:1 HE-AACv1 transmissions to AC-3 or DTS and of Enhanced AC-3 transmissions to 5:1 AC-3 signal is mandatory unless the receiver provides a minimum 5 channel audio reproduction system capable of driving at least 5 speakers.*<br>*Presentation of the transcoded or native AC-3 signal on SPDIF output (if present) is mandatory.* |
| Audio Multi-Language | Language shall be selectable. | Behaviour as specified in §7.4.1.1 |
| Video Decoder (SD mode) | MPEG-2 Video Main Profile @ Main Level *and*<br>*H.264/AVC High Profile @ Level 3 (576i25)* SHALL be supported.<br><br>Video Aspect Ratio: 4:3; 16:9. | The support of a picture aspect-ratio conversion function to transform programmes broadcast in the format 16:9 to 4:3 (and vice-versa) is mandatory. The receiver shall follow indications given by the Active Format Descriptor, if present (see section 7.5.3)<br>Ref. : [9], [2] |

[2] It is expected that this old and inefficient audio codec will remain confined to legacy SD services on DVB-T and it will not be used on DVB-T2 alongside advanced video codecs like H.264/AVC and HEVC.

[3] *It is expected that the Enhanced AC-3 codec should be used for DVB-T2 services, alongside advanced video codecs like H.264/AVC and HEVC. Older and less efficient codecs such as AC-3 are not recommended for DVB-T2 services. It must be noted that any Enhanced AC3 receiver is also, by design, an AC-3 receiver*

| Feature | Specification | Comment |
|---|---|---|
| *Video Decoder (HD mode)* | *H.264/AVC High Profile @ up to Level 4 support is MANDATORY for the following conformance points:*<br>*- 1080i25*<br>*- 1080p25*[4]<br>*- 720p50*<br>*- 720p25*<br>*- 576p50*[5]<br><br>*HEVC Main 10 Profile @ up to Level 4.1 support is MANDATORY*[6] *for the following conformance points (16:9 aspect ratio):*<br>*- 1080p50*<br>*- 720p50*<br>*- 540p50*[7]*.*<br><br>*3DTV receivers SHALL also be capable of correctly rendering (3D iDTVs) or notifying through HDMI (3D STBs) at least the following "Frame-Compatible" 3DTV formats encoded using H.264/AVC:*<br>*- 720p50 Top-and-Bottom*<br>*- 720p50 Side-by-Side*<br>*- 1080i25 Side-by-Side*<br>*and the following format encoded using HEVC:*<br>*- 1080p50 Top-and-Bottom*<br><br>*See Annex E for expected behaviour of 2D receivers against Frame-Compatible and Service Frame Compatible 3DTV signals.* | *Ref.: [8], [9], [53], [57]*<br><br>*For Frame-Compatible 3DTV signalling at video level with H.264/AVC:*<br>▪ *frame packing arrangement Supplemental Enhancement Information (SEI) message is used*<br>▪ *SEI message related to every video frame*<br>▪ *SEI message in a separate Network Abstraction Layer (NAL) unit*<br>▪ *frame_packing_arrangement _cancel_flag set to 1 indicates transition to 2D*<br><br>*For Frame-Compatible and Service Frame Compatible 3DTV signalling at video level with HEVC:*<br>▪ *general_non_packed_constraint_flag set to 0 is used to indicate a frame packing arrangement SEI messages is present in the CVS*<br>▪ *frame packing arrangement Supplemental Enhancement Information (SEI) message is used*<br>▪ *SEI message related to every video frame*<br>▪ *SEI message in a separate Network Abstraction Layer (NAL) unit*<br>▪ *frame_packing_arrangement _cancel_flag set to 1 indicates transition to 2D*<br><br>*According to [9] (section 5.7.1.2) H.264/AVC HDTV decoders SHALL support frame cropping and Sample Aspect Ratio (SAR) value as encoded within Video Usability Information.*<br><br>*According to [9] (section 5.14.1.5) HEVC HDTV decoders SHALL support the default display window parameter as encoded within Video Usability Information.* |

Table 1: Mandatory features table

[4] *Broadcasters might be interested into this format for certain applications*
[5] *Broadcasters might consider this format (Enhanced Definition TV) for new H.264/AVC SD services.*
[6] *Support for HEVC Tiles and WPP (Wavefront Parallel Processing) is OPTIONAL*
[7] *720p50 and 540p50 (16:9 aspect ratio) are two formats which broadcasters might consider for new HEVC near-SD services.*

## 6.2. Interaction Channel

*Support to interactive TV, with specific reference to true interactive services, including media delivery over broadband (IP) connections, is deemed of paramount importance for HD receivers. Therefore*

- *Both STB and iDTV receivers SHALL have at least one wireline interaction channel*

*Two families of interaction channel implementations are in fact considered[8]:*

- *wireline interaction channel*
- *mobile interaction channel.*

*It is up to the manufacturer to implement, as an option, a mobile interaction channel in addition to the wireline default one.*

*In the scope of this document "broadband (IP) connections" are best-effort Internet connections offered by ISPs. In other words, the services enabled by this addendum don't strictly require a connection to the (managed) network of an IPTV Service Provider.*

*Media contents can be delivered over broadband (IP) lines either as linear services or as Content on Demand (CoD) type of services.*

*A linear IP service simply reproduces on a broadband connected receiver the same user experience of a conventional DVB service: it can be selected directly through the remote (via numeric keys or Ch+/Ch- button) or from an EPG; always through the remote user can get information about current and next events, select among different audio languages, turn subtitles on/off, etc.. Consumption of the content is started from the point where user "tuned" into.*

*Content on Demand (CoD) service is a service where a user can select the individual content items they want to watch from a list of available contents. Consumption of the content is started upon user request.*

*2 types of CoD services are addressed in the following:*

- *Streamed CoD services, where content is consumed while the content itself is being delivered (real-time streaming)*
- *Download CoD services, where the whole content has to be downloaded first to the local storage in the receiver before consuming it. Consumption is then independent of the delivery.*

*Support of Streamed CoD services is MANDATORY.*
*Support of Download CoD services is RECOMMENDED in receivers with internal or external storage capabilities.*

### *6.2.1. Wireline interaction channel*

*A wired or wireless (IEEE 802.11 b/g/n) Ethernet port for connecting to broadband access services (e.g. ADSL, FTTH) through a residential gateway (e.g. ADSL modem, ADSL modem/router, FTTH termination) would offer the user the full potential of interactivity, through always-on and broadband capabilities.*

[8] this classification refers to the technology used to access the public network: so for instance a receiver connected via a Wireless LAN to an ADSL modem/router fits into the wireline interaction channel family

*From the application viewpoint, Ethernet connections can be seen either as LAN (connectionless) or virtual dial-up connections. The former is mandatory, whereas the latter, which requires support for PPPoE by the receiver, is optional.*

| Feature | Specification | Comment |
|---|---|---|
| *Ethernet* | *IEEE 802.3*<br>*10/100 Mbit/s autosense* | |
| *IP address* | *IPv4 (MANDATORY) or IPv6 (RECOMMENDED) address obtained either:*<br>• *via DHCP or*<br>• *manually* | *DCHP shall be the factory default. For manual configuration it shall be possible to insert from the resident menu:*<br>▪ *static IP address*<br>▪ *Subnet Mask value*<br>▪ *Default Gateway's IP address*<br>▪ *Primary and Secondary DNS Server's IP address* |
| *Optional Supplementary Protocol* | *PPPoE* | *For virtual dial up. The resident menu shall allow to introduce username and password* |
| *Basic communication protocol* | *HTTP 1.1 [44] SHALL be supported.*<br>*HTTP REDIRECT SHALL be supported.* | |
| *Secure communication protocol* | *HTTPS [63] SHALL be supported.* | *Embedding of TLS root certificates listed in [68] is RECOMMENDED* |
| *HTTP Proxy* | *A resident menu for defining an HTTP proxy server is RECOMMENDED.* | |
| *Protocols for streaming* | *Unicast streaming using HTTP 1.1 [44] SHALL be supported as defined in clause 5.3.2.2 of the OIPF Protocols specification [45]. In order to reduce unnecessary network usage, by allowing partial retrieval for use in cases such as trick play or seek operations, the Range HTTP header in a GET request form SHALL be supported.*<br><br>*Unicast streaming using HTTPS [63] SHALL be supported as well.*<br><br>*HTTP REDIRECT SHALL be supported.*<br><br>*Dynamic Adaptive Streaming over HTTP (DASH) solution specified by MPEG [60] SHALL be supported, both for free and DRM protected contents.* | *To optimize the streaming user experience over best-effort broadband lines when DASH is not used, the receiver SHALL implement proper buffering and playback strategies to cope with varying network conditions. The details of such strategies are implementation dependant.*<br><br>*Maximum bit rate of video delivered over broadband (IP) lines that the receiver SHALL be able to correctly decode and present for Streamed CoD services is 8 Mbit/s (HTTP) and 5 Mbit/s (HTTPS).*<br><br>*Receivers SHALL support the ISOBMFF Live and On Demand Profiles defined in MPEG-DASH, as further profiled by DVB as DVB-DASH [69] and by HbbTV in HbbTV 2.0.1 [6]. In particular, linear IP services are implemented using DVB-DASH Live Profile.* |
| *Protocols for download* | *If content download is supported, HTTP SHALL be supported as defined in clause 5.2.3 of the OIPF Protocols specification [45].* | |

| Feature | Specification | Comment |
|---|---|---|
| *Media formats* | *See Table 3* | *Further to the constraints specified in [9], those specified for Video and Audio formats in clauses 5 and 8 of OIPF Media Formats specification [43] apply.*<br>*Some restrictions on the media types allowed within some specific container may apply (see below).* |
| *Media container* | *For delivery of media contents over broadband (IP) lines the following standard container formats SHALL be supported:*<br>*- MPEG-2 Transport Stream (TS)*<br>*- MPEG-4 File Format (MP4) [42]* | *Further to the constraints specified in [9], those specified for "TS system layer format" in clause 4.1 of OIPF Media Formats specification [43] apply. In particular, only a single program SHALL be contained in the Transport Stream container. The TS SHALL contain only one Program Map Table (PMT).*<br>*Frame-Compatible and Service Frame Compatible 3DTV streams MAY contain AVC_video_descriptor or HEVC_video_descriptor in PMT (see §7.2.2.4 and §7.1.2.2.7).*<br>*For the MP4 container the constraints specified in clause 4.2 of OIPF Media Formats specification [43] apply.*<br>*Frame-Compatible and Service Frame Compatible 3DTV MP4 files MAY contain information about the frame packing arrangements at container level in the Stereo Video box [54].* |
| *Subtitles* | *For media contents delivered in TS container the DVB Subtitles format SHALL be supported.*<br>*Support of DVB Subtitles in conjunction with frame-compatible 3DTV formats is OPTIONAL.*<br><br>*For media contents delivered in a MPEG-4 File Format (MP4) container the following subtitle format SHALL be supported: EBU-TT-D [70]* | *Subtitles delivered via HTTP Progressive Download or via DASH SHALL be encapsulated in ISOBMFF container in accordance to EBU Carriage of EBU-TT-D in ISOBMFF [71].*<br><br>*Delivery of EBU-TT-D subtitles as a separate document in a single file is supported in the context of HbbTV 2.0.1 [6].* |
| *Content Access* | *The Content Access Streaming Descriptor structure with the syntax and MIME type defined in Annex E.2 of the OIPF DAE specification [73] SHALL be supported to describe content available for streaming.* | *"The content access descriptor has an optional <ParentalRating> element which can be used to carry parental rating information associated with the content that it references." (see §8.2.2)* |

Table 2: Wireline interaction channel features

*The media formats to be supported within each container type are the following ones:*

| | | Container | |
|---|---|---|---|
| **Media Format** | | **TS** | **MP4/DASH** |
| *Video* | *MPEG-2 Video Main Profile @ Main Level* | *X* | |
| | *H.264/AVC Baseline Profile @ Level 2* | | *X* |

| Media Format | | Container | |
|---|---|---|---|
| | | TS | MP4/DASH |
| | *H.264/AVC High Profile @ up to Level 4 for the following conformance points:* | | |
| | *1080p25* | *X* | *X* |
| | *1080i25* | *X* | *X* |
| | *720p50* | *X* | *X* |
| | *720p25* | *X* | *X* |
| | *576p25* | *X* | *X* |
| | *576i25* | *X* | *X* |
| | *HEVC Main 10 Profile @ up to Level 4.1 for the following conformance points:* | *X* | *X* |
| | *1080p50* | *X* | *X* |
| | *1080p25* | *X* | *X* |
| | *720p50* | *X* | *X* |
| | *720p25* | *X* | *X* |
| | *540p50* [9] | *X* | *X* |
| *Audio* | *MPEG-1 Audio Layer I & II* [10] | *X* | |
| | *AAC-LC up to level 2 for stereo and level 4 for multichannel (5.1)* [11] | *X* | *X* |
| | *HE-AACv1 up to level 2 for stereo, level 4 for multichannel (5.1)* | *X* | *X* |
| | *Enhanced AC-3 (aka Dolby Digital Plus) up to 5.1 channels* | *X* | *X* |
| *Teletext* | *EBU Teletext carried in DVB streams* | *X* | |
| *Subtitles* | *DVB Subtitles* | *X* | |
| | *EBU-TT-D Subtitles* | | *X* |

Table 3: Container/media compatibility matrix

*Regarding DASH, it must be noted that all video formats listed above are supported by HbbTV 2.0.1 [6] but 576p25, which is required for backward compatibility with previous versions of this document [25] and with legacy contents.*

*3DTV receivers SHOULD also support the following formats encoded in H.264/AVC (TS and MP4 container, including the DASH case):*

- *1080i25 Side-by-Side*
- *720p50 Side-by-Side*
- *720p50 Top-and Bottom*

*UHD receivers SHOULD also support DVB's UHDTV contents, as defined in [9], delivered via IP (TS and MP4 container, including the DASH case), which call for HEVC Main 10 Profile @ Level 5.1 video decoding [9][74] for the following resolutions at 25p and 50p frame rates:*

- *3840x2160*
- *3200x1800*
- *2560x1440*

*Maximum bit rate of UHDTV video delivered over broadband (IP) lines that UHD receivers SHALL be able to correctly decode and present for Streamed CoD services is 25 Mbit/s (HTTP).*

[9] *720p50 and 540p50 (16:9 aspect ratio) are two formats which broadcasters and/or OTT providers might consider for new HEVC near-SD services.*
[10] *It is expected that this old and inefficient audio codec will not be used alongside advanced video codecs like H.264/AVC and HEVC.*
[11] *Any HE-AACv1 should decode AAC-LC signal but a separate entry for the latter is still kept because of known interoperability issues. Manufacturers are warned that it will be removed in the next release of this document.*

*In order to make video encoded with H.264/AVC Baseline Profile decodable also by a Main/High Profile decoder, support of AVC error resilience tools included in Baseline Profile is OPTIONAL (i.e.* `constraint_set1_flag` *is equal to "1" in case of Baseline Profile).*

*Particular cases of "self-contained" contents which can be delivered over broadband (IP) lines are audio-only streams. The following formats SHALL be supported for such streams:*

- *MPEG-1 Audio Layer III*
- *HE-AACv1*
- *AAC-LC*

*Audio-only streams based on the latter two formats can be carried either using Audio Data Transport Stream (ADTS) [67] or within the MPEG-2 TS and MP4 containers.*

*Usage of MPEG-1 Audio Layer III is restricted to audio-only streams, i.e. it will not be used for audiovisual streams, either broadband or broadcast.*

*For the sake of backward compatibility with DASH profile defined in previous HD-Book versions, implementations SHOULD comply with the following additional constraints:*

- *In case of ISOBMFF container each 'moof' box SHALL contain only one track fragment box 'traf' and associated media data box 'mdat' SHALL contain only the media samples referenced from that track fragment box*
- *The Movie Fragment, which consists of a 'moof' box and a 'mdat' box, SHALL correspond to a Segment element in a DASH MPD.*
- *Representations described in a MPD MAY be organized in up to 16 different <AdaptationSet> elements for each Period*
- *In each <AdaptationSet> element is possible to describe no more than 16 different representations for video/audio tracks*
- *In case of multiple <AdaptationSet> elements containing different video representations the receiver can select the first one it is able to present*
- *In case of multiple <AdaptationSet> elements for the same media component (e.g.: video) the receiver SHALL select by default the one with a Role element with a value of "main" according to urn:mpeg:dash:role:2011 scheme. If such a Role element is not defined the receiver can select the first <AdaptationSet> element it is able to present*
- *Representations included in an <AdaptationSet> element MAY vary in terms of codec Profile@Level, Resolution, and Bitrate*
- *Media Segments SHALL have a minimum duration of 2s, except for the last media segment which MAY be shorter.*

### *6.2.2. Mobile interaction channel*

*Any advanced packet-switched mobile connection (e.g. GPRS over EDGE, HSDPA, LTE, …) can be used as mobile interaction channel.*

## 6.3. I/O Connectors

### *6.3.1. Mandatory Connectors*

The following connectors shall be present in any applicable receiver (see comments).

| Connector | Specification | Comment |
|---|---|---|
| Input RF connector. | Input: IEC 61169-2 Female, 75 Ohm [82] | Tuner input |

| Connector | Specification | Comment |
|---|---|---|
| SCART Connector (Primary) | Peritelevision standard [4]<br>• RGB<br>• CVBS: PAL Out<br>• Audio Output<br>A/V Control Pin 8 | For connection to old TV sets. Only applicable to STBs.<br><br>As an option, the user menu may offer the possibility to output a Y/C signal instead of the RGB signal.<br><br>*In case of HD or UHD signal, the downsampled SD version has to be presented on this output, both in composite and component mode, with the same user settings defined in the menu page for connection to 4:3 or 16:9 TV sets. Teletext reinsertion on VBI is required (see §8.1.2).*<br><br>*The stereo output pins will carry one of the following:*<br>*• a mono or stereo signal, in the case of the received audio component being mono or stereo;*<br>*• a two channel downmixed signal, in the case of the received audio component being multi-channel.*<br><br>*SCART Connector is OPTIONAL on UHD STBs.* |

| Connector | Specification | Comment |
|---|---|---|
| *Output HDMI Connector with HDCP content protection* | *Type A (Female) [38]*<br><br>*Automatic audio/video sync is required.*<br><br>*HDCP [39] must be ON by default.*<br><br>*1080p50 is the recommended default output format.*<br><br>*When Frame-Compatible and Service Frame Compatible 3DTV formats are decoded, receivers SHALL transmit an accurate HDMI Vendor Specific InfoFrame (as per section 8.2.3 of [53]) at least once every two video fields*<br><br>*Receivers SHALL handle an HDMI Vendor-Specific Data Block (HDMI VSDB) in the E-EDID Data Structure as indicated in section 8.3.2 of [53].*<br><br>*HDMI output(s) on UHD STBs SHALL support HDMI version 2.0 [79] and HDCP version 2.2 Copy Protection [80] when they output with a resolution higher than 1920X1080 a UHD signal as specified in §6.1.2.1.*<br><br>*NOTE: When HDCP2.2. is supported by the HDMI sink , it is highly recommended to keep HDCP 2.2 protection constant for all the services to avoid delays when switching channel.* | *For digital connection of STBs to HD Ready or HD Ready 1080p or UHD displays.*<br><br>*According to DIGITALEUROPE HD TV and HD TV 1080p logos' requirements, a "dynamic" output (unscaled) mode shall be available where the HD output format (720p50 or 1080i25) will match the HD transmission format (720p50 or 1080i25 respectively) based on EDID. By avoiding possible (even multiple) format conversions, such mode would in theory provide the best video quality. But due to limitations in early HDMI/HDCP implementations it would likely cause some substantial extra delay, with respect to a fixed 720p50 or 1080i25 output setting, when moving between services or events with different HD or SD transmission formats. For these reasons, the dynamic output mode shall be available in user menus but not necessarily as the default value.*<br><br>*In order to possibly minimize the number of cascaded conversions, when dynamic output mode is selected SD output towards HD Ready or HD Ready 1080p displays SHALL be set to 576p50.*<br><br>*To allow connection of UHD STBs to legacy HD displays it SHALL be possible setting output resolution via system menus to UHD (default) or HD (1920x1080).*<br><br>*UHD capable STBs outputs UHD video signals, when set to do so:*<br>*- with a resolution of 3840x2160 pixels*<br>*- at frame rates 25p and 50p*<br>*- with a minimum supported bit depth of 8 bits*<br>*- at a chroma sub-sampling rate of 4:2:0 for 50p and 4:2:2 for 25p*<br>*- with minimum supported colorimetry according to BT.709 [81]* |

| Connector | Specification | Comment |
|---|---|---|
| *Input HDMI Connector with HDCP content protection* | *Type A (Female) [38]*<br><br>*E-EDID support, including HDMI VSDB (Vendor-Specific Data Block) Lipsync-related fields, is required.*<br><br>*HDCP [39] must be ON by default.*<br><br>*It's highly RECOMMENDED that 3DTV capable iDTVs interpret HDMI Vendor Specific InfoFrame packet (as per section 8.2.3 of [53]).*<br><br>*3DTV capable iDTVs SHALL contain an HDMI Vendor-Specific Data Block (HDMI VSDB) in the E-EDID Data Structure as indicated in section 8.3.2 of [53].* | *For digital connection of STBs to HD Ready or HD Ready 1080p TV sets.*<br><br>*Support of HDMI ARC (Audio Return Channel) specified in [38] is MANDATORY at least on one input unless Output SPDIF Connector, per §6.4.2, is present.*<br><br>*HDMI input(s) on UHD TV sets SHALL support HDMI version 2.0 [79] and HDCP version 2.2 Copy Protection [80].*<br><br>*UHD capable inputs accept UHD video signals:*<br>*- with a resolution of 3840x2160 pixels*<br>*- at frame rates 25p and 50p*<br>*- with a minimum supported bit depth of 8 bits*<br>*- at a chroma sub-sampling rate of 4:2:0 for 50p and 4:2:2 for 25p*<br>*- with minimum supported colorimetry according to BT.709 [81]* |
| *Ethernet Port* | *RJ 45 Connector* | *Mandatory for receivers with wireline interaction channel also in case they provide (in-house) wireless access*[12]*.* |
| Smart card slot | ISO 7816 1,2,3 with T=0 and T=1 | For CA and non-CA applications.<br>Mandatory unless a CIplus slot is available. |
| *Common Interface (CI Plus)* | *EN 50 221, as explained in Chapter 8, with CI Plus extensions [37]* | *Applicable and mandatory only for iDTVs with screen diagonal over 30cm (13").* |
| *USB Port (Host)* | *USB Type A Connector* | *Compliant with USB 2.0 or later specification [52].*<br><br>*For user-managed software upgrade and/or for attaching external storage media* |

Table 4: Mandatory connectors table

### *6.3.2. Optional Connectors*

The following table includes a non-exhaustive list of connectors which might be present in some receivers. When present the specifications given therein do apply.

[12] An USB port could actually turn into an Ethernet (wired or wireless) or advanced mobile (GPRS, EDGE, UMTS, HDSPA) port through a suitable adapter but the sole presence of such a port doesn't fulfil the requirement. A receiver with USB port will be considered compliant with this requirement only if the aforementioned adapter would come bundled with the receiver itself.

| Connector | Specification | Comment |
|---|---|---|
| *Output HDMI Connector with HDCP content protection* | *Type A (Female) [38]*<br>*Automatic audio/video sync is required.*<br>*HDCP [39] must be ON by default.* | *For digital connection to other external equipment (e.g. Home Theater, Video Projector).* |
| Output RF connector (pass-through) | IEC 61169-2 Male [82] | "Loop through" facility. Only applicable to STBs.<br>Necessary to transmit the signal from the receiving antenna to a VCR, and/or to a TV set.<br>In presence of the RF modulator, this output carries also, on a user selectable channel, the digital (decoded) signal |
| SCART In Connector (1) | Peritelevision standard [4]<br>• RGB In<br>• CVBS: PAL In<br>• Audio In<br>• A/V Control Pin 8 | Applicable only to iDTVs, for connecting legacy SD devices. |
| SCART Connector (Secondary) | • CVBS: PAL Out<br>• Audio: Output<br>• Y-C (super VHS) | Useful to record Digital Channels on a VCR. Such output must not to be affected by OSD (On Screen Display) graphics. Applicable only to STBs.<br>*In case of HD signal, the downsampled SD version has to be presented on this output, either/both in composite or/and component mode (if present), with the same user settings defined in the menu page for connection to 4:3 or 16:9 TV sets. Teletext reinsertion on VBI is recommended (see §8.1.2).*<br>*The stereo output pins will carry one of the following:*<br>*• a mono or stereo signal, in the case of the received audio component being mono or stereo;*<br>*• a two channel downmixed signal, in the case of the received audio component being multi-channel.* |

| Connector | Specification | Comment |
|---|---|---|
| SCART Connector (Primary) | Peritelevision standard [4]<br>• RGB<br>• CVBS: PAL Out<br>• Audio Output<br>A/V Control Pin 8 | For connection to external legacy SD equipment.<br>As an option, the user menu may offer the possibility to output a Y/C signal instead of the RGB signal.<br>*In case of HD signal, the downsampled SD version has to be presented on this output, both in composite and component mode, with the same user settings defined in the menu page for connection to 4:3 or 16:9 TV sets. Teletext reinsertion on VBI is required (see §8.1.2).*<br>*The stereo output pins will carry one of the following:*<br>*• a mono or stereo signal, in the case of the received audio component being mono or stereo;*<br>*• a two channel downmixed signal, in the case of the received audio component being multi-channel.* |
| RCA Connectors (Composite) | • 1 Video<br>• 2 Audio (left/ right) | *In case of HD signal, the composite downsampled SD version has to be presented on the video output, with the same user settings defined in the SCART menu page for connection to 4:3 or 16:9 sets. Teletext reinsertion on VBI is required.*<br>*The stereo output connector will carry one of the following:*<br>*• a mono or stereo signal, in the case of the received audio component being mono or stereo;*<br>*• a two channel downmixed signal, in the case of the received audio component being multi-channel.* |
| *RCA Connectors (Component)* | • *3 Video (YPbPr) as per CEA 770.3*<br>• *2 Audio (left/ right)* | *In case of HD signal, the composite downsampled SD version has to be presented on the video output, with the same user settings defined in the SCART menu page for connection to 4:3 or 16:9 sets.*<br>*The stereo output connector will carry one of the following:*<br>*• a mono or stereo signal, in the case of the received audio component being mono or stereo;*<br>*• a two channel downmixed signal, in the case of the received audio component being multi-channel.* |
| Serial data port (RS-232) 9-pin | D-sub connector Female | |
| SIM slot | Receptacle for standard SIM.<br>Access to the SIM slot shall not need opening the case of the receiver. | For receivers with mobile interaction channel. The slot may be either inside the receiver box itself or in an external device. |
| Mobile high gain antenna connector | One of three possible standards<br>• RP TNC female<br>• RP MC Card female<br>• RP SMA female | For receivers with mobile interaction channel. |

| Connector | Specification | Comment |
|---|---|---|
| Output SPDIF Connector | As per [27] with Optical connector. | A second SPDIF output with Electrical (RCA) connector is OPTIONAL.<br>This output may be omitted when the receiver provides a minimum 5 channel audio reproduction system capable of driving at least 5 speakers with a digital bitstream. |
| *Common Interface (CI Plus)* | *EN 50 221, as explained in Chapter 8, with CI Plus extensions [37]* | *As an alternative to embedded CA* |

Table 5: Optional connectors table

### *6.3.3. Audio outputs matrix*

*The following matrix specifies which audio shall be presented on which output (if present) of a compliant receiver, based on the received signal, both for broadcast and broadband:*

| | HDMI (including ARC) | SCART | RCA | SPDIF |
|---|---|---|---|---|
| *Mono/stereo audio (any codec)* | *Decoded PCM mono/stereo audio* | *Decoded analog mono/stereo audio* | *Decoded analog mono/stereo audio* | *Decoded PCM mono/stereo audio* |
| *AC-3 5.1 audio* | *AC-3 5.1 audio or decoded PCM multichannel audio or stereo downmix of multichannel audio, in the given preference order, based on sink's capabilities (as per EDID)* | *Analog stereo downmix of multichannel audio* | *Analog stereo downmix of multichannel audio* | *AC-3 stream* |
| *Enhanced AC-3 5.1 audio* | *Enhanced AC-3 5.1 audio or AC-3 5.1 transcoded stream or decoded PCM multichannel audio or stereo downmix of multichannel audio, in the given preference order, based on sink's capabilities (as per EDID)* | *Analog stereo downmix of multichannel audio* | *Analog stereo downmix of multichannel audio* | *AC-3 5.1 transcoded stream* |
| *HE-AAC v1 5.1 audio* | *AC-3 or DTS 5.1 transcoded stream or decoded PCM multichannel audio or stereo downmix of multichannel audio, in the given preference order, based on sink's capabilities (as per EDID)* | *Analog stereo downmix of multichannel audio* | *Analog stereo downmix of multichannel audio* | *AC-3 or DTS 5.1 transcoded stream* |

Table 6: Audio channel mapping

It SHALL be possible to change via system menus the default output on HDMI, amongst those notified by the sink via EDID.

### 6.3.4. Active Format Descriptor

Transmission of this description by the broadcaster is OPTIONAL, but, when present, use of this description by the receiver is MANDATORY.

As explained in Annex B of ETSI TS 101 154 [9] “The Active Format Description (AFD) describes the portion of the coded video frame that is "of interest". It is intended for use in networks that deliver mixed formats to a heterogeneous receiver population. The format descriptions are informative in nature and are provided to assist receiver systems to optimize their presentation of video.

“[…] The AFD is intended for use where there are compatibility problems between the source format of a programme, the format used for the transmission of that programme, and the format of the target receiver population. For example, a wide-screen production may be transmitted as a 14:9 letter-box within a 4:3 coded frame, thus optimized for the viewer of a 4:3 TV, but causing problems to the viewer of a wide screen TV.
The appropriate AFD may be transmitted with the video to indicate to the receiver the "area of interest" of the image, thereby enabling a receiver to present the image in an optimum fashion (which will depend on the format and functionality of the receiving equipment combined with the viewer's preferences). […]
The AFD itself does not describe the aspect ratio of the coded frame (as this is described elsewhere in the MPEG-2 video syntax).”

The use, by the broadcaster, of this description allows it to optimize the presentation of its program for both 4:3 and 16:9 displays. Therefore, by default, the receiver shall make use of this descriptor. However, the manufacturer may implement a manual override and/or a manual disable.

#### 6.3.4.1. Syntax and Semantics

For standard definition programs, the receiver SHALL recognize AFD transmitted according to [9] Annex B.2.2.

*In case of HDTV compatible receiver, the receiver SHALL recognize AFD transmitted according to [9] Annex B.3.2.*

#### 6.3.4.2. Valid Values for Descriptor

All values referenced in [9] Annex B “table B.2 active_format” are valid in the broadcast signal.

#### 6.3.4.3. Behaviour of receiver in presence of AFD

The receiver SHALL behave in accordance with “The DTG Receiver Implementation Guidelines” [35].

NB: AFDs supplement and qualify - but do not replace - the aspect ratio flag carried in the MPEG sequence header of digital broadcasts. Receivers must interpret both the aspect ratio flag and the AFD in order to present the image in the correct manner.

#### 6.3.4.4. Analogue output of the receiver

The receiver should reinsert WSS data in analogue standard definition outputs according to what is specified in [35].

#### 6.3.4.5. AFD and HDMI

*Receivers with HDMI output are recommended to provide at least one of the following methods to process aspect ratio and AFD information for video output on HDMI:*

- *Provide a reformatting function for the video to match the aspect ratio of the display*

*based on AFD, aspect ratio and user preference as per section 6.4.3.5 in [35] (for 16:9 displays). Support for scaling to 4:3 aspect ratio for HDMI is optional (since consumer HD displays are 16:9). Aspect ratio signaling in the HDMI AVI Infoframebits R0..R3, M0, M1 (see CEA-861) shall be set in accordance with the properties of the video on the output.*

- *Pass the video to the HDMI output unprocessed with respect to AFD and aspect ratio scaling, and pass AFD and aspect-ratio signaling in the video to the HDMI output as part of the AVI Infoframe bits R0..R3, M0, M1 (see CEA-861)*

## 6.4. Remote Control

### *6.4.1. Introduction*

To ensure a common and stable reference for application developers and consumers, it is necessary to specify a certain number of points concerning the remote control. This necessity has been identified and confirmed by different groups (e.g. ETSI STF228 on ”User interoperability criteria”, see [21]).

The points taken into consideration cover aspects of:

- physical layout of the remote
- labelling of the keys
- behaviour on “undo” commands
- interaction of output from the remote with the OSD
- interaction with applications for alpha-numeric input

In all cases where possible, the requirements are based on specifications produced by other bodies. Lastly this chapter contains some advice on good remote control design, taken from extensive research conducted elsewhere. It is highly recommended manufacturers follow this advice – for the benefit of the consumer.

Unlike vertically integrated digital platforms it is not possible to mandate a single remote control design. However, it is essential to have a common minimum of remote-control functionality to ensure that all broadcast services – and in particular interactive applications - are available to the viewer as intended by the broadcaster. In addition, any labelling used needs to be consistent, both to allow the inclusion of on-screen instructions in broadcast services and to enable an easy dialogue with any support staff, e.g. call-centres.

### *6.4.2. Overview*

The mandatory keys and key events available to the application are very limited, and thus keys and key event may vary from manufacturer to manufacturer. Even if all necessary (for the consumer and the applications) keys are present on the remote, there is no obligation to make the events available to the application.

### *6.4.3. Generic functional description of the remote control*

The remote control is used for different purposes:

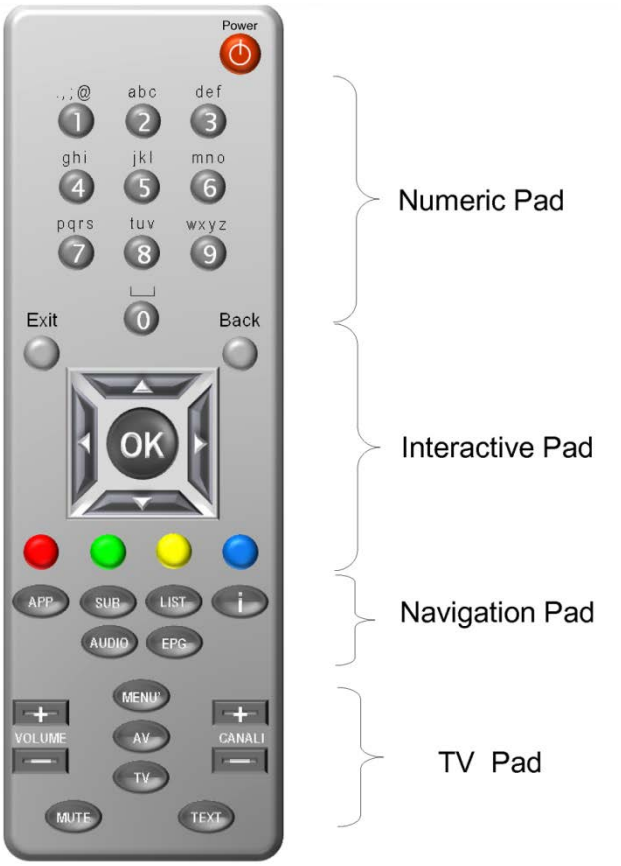


Figure 1: Typical Remote Control

- TV/receiver control
- channel selection
- accessing information about programs and services
- interactivity

It is strongly recommended that the keys be grouped together by function, and the groupings should be clearly separated (see “Easy TV” research [1] ).

### *6.4.4. General Recommendations*

The following recommendations are based on international studies and on evidence coming out of qualitative research based on MHP services already deployed in the last 10 years in Italy.

#### 6.4.4.1. The Main Remote

Receiver remotes need to make possible controlling all the main functions of the TV Set. It has to replace the analogue remote by keeping the same simplicity and user friendliness (few & large keys are needed).

#### 6.4.4.2. Single hand friendly

- The remote control needs to stay comfortably in one hand and be balanced in weight. A rubber band can be useful if placed around the border of the remote.
- The remote will stay in one hand and the keys will be pressed with the thumb. All the keys need to stay in “thumb range”.

#### 6.4.4.3. Clear structure

Keys for normal TV viewing and keys for interactivity and navigation need to be grouped in clearly separated sections of the remote

#### 6.4.4.4. Channel selection

- Speed: channel selection (video-video switch) should take less than 0,8 seconds both for an inband or an outband switch. For a channel switch implying a change of hierarchical mode, a maximum of 1 second is tolerable for switching. The switching time shall be calculated using the channel up/down button and will not consider the time for validating the channel number to switch to when using the numeric pad for channel selection..
- AV source dedicated key for VCR or DVD (or other receiver)
- Led on the receiver to indicate the reception of signal coming from the remote.

#### 6.4.4.5. TV controls

STBs whose remote gives the opportunity of directly controlling volume on the TV set were ranked at the top both in Easy TV and Italian Broadcasters' research.

#### 6.4.4.6. Now and Next

Need for a dedicated key for Now-and-Next information and for accessing on screen help for navigating channels and services.

#### 6.4.4.7. Navigation keys

- Navigation keys need to be near and consistently placed.
- Colour keys need to be placed following on screen layout.
- There has to be one only red key on the remote
- Symbols: use well known metaphors.

### *6.4.5. The Numeric Pad*

#### 6.4.5.1. Overall Function Description

The Numeric Pad is used:

- For channel selection
- In HbbTV, for application specific purposes.
- For various (manufacturer proprietary) purposes within the receiver's menus

#### 6.4.5.2. Requirements for the Numeric Pad

##### *6.4.5.2.1 Time-out for channel selection*

It is recommended that the time-out for channel selection/switching through numeric pad should be less or equal to 1 second *for SD video and 2 seconds for HD video*[13]. Longer time out length is perceived as misfunctional or annoying by users (see Easy-TV research findings in Annex B)

##### *6.4.5.2.2 Labelling of Numeric Pad keys*

The labelling of the numeric pad keys shall be as shown in Figure 1. This labelling is fully compliant with ETSI ES 202 130 [16]. Letter labels can be also printed on the numeric keys, if they are clearly visible.

[13] It is acknowledged that meeting such targets will depend also on broadcasted signal (e.g. MPEG GOP size) and HDMI/HDCP switching time (if dynamic output mode has been selected)

### 6.4.6. Interactive Pad

#### 6.4.6.1. Overall Function Description

The Interactive Pad is used:

- For navigating within any receiver proprietary GUI
- For navigating within any HbbTV application

#### 6.4.6.2. Requirements for Interactive Pad

No receiver proprietary function shall be assigned to the interactive pad when outside of a proprietary STB menu or sub-menu and, in general, when in TV viewing mode condition (see definition in § 4.1). As a consequence, the arrows should not be used neither for channel switching (Ch+ / Ch – should be used instead) nor for volume adjustments. These functions have to be performed by specific dedicated keys.

No key that can bring to a sudden and unexpected killing of an HbbTV application should be placed near to the interactive pad keys.


Figure 2: The Interactive Pad

The order of the colour keys shall be strictly followed (Red, Green, Yellow, and Blue).

### 6.4.7. The Navigation Pad

#### 6.4.7.1. Overall Function Description

The Navigation Pad is used:

- For accessing SI tables data (e.g.: EIT present/following, AIT)
- For accessing the overall channel list
- For selecting the alternative audio track (if any)
- For accessing the EPG application (resident or on-air)
- For accessing Subtitles (DVB or Teletext)

Not all the keys shown in the Navigation PAD are mandatory and have to be included on the remote control.

Refer to following section in the Remote Control chapter for more detailed specifications.

#### 6.4.7.2. Suggestions for Navigation Pad

All the keys in this particular group are receiver proprietary and labels shown in the picture are to be taken as suggestions, but are completely up to the manufacturer for definition.
Shape, disposition and order of such keys are up to the manufacturer. It is warmly suggested using keys with a clearly distinct shape for identifying these keys and distinguishing them from Interactive Pad keys.


Figure 3: The Navigation Pad

It is strongly suggested keeping these keys grouped together in order for the user to access them easily.

Availability on remote controls, or at least on custom models, of a dedicated “hot” key for people who are blind and visually impaired to easily access Audio Description possibly associated to certain programs is RECOMMENDED.

### *6.4.8. The TV Pad*

#### 6.4.8.1. Overall Function Description

The TV Pad is used:

- For accessing to receiver proprietary settings.
- For controlling volume and for channel hopping.
- For selecting alternative video sources (DVD, VHS, Gaming Consoles…).
- To return to TV mode.

Not all the keys shown in the TV Pad are mandatory and have to be included on the remote control.

Refer to following section in the Remote Control chapter for more detailed specifications.

All the keys in this particular group are receiver proprietary and labels shown in the picture are to be taken as suggestions, but are completely up to the manufacturer for definition.
Keys for volume adjustments and for channel up/down scrolling should be easy to identify and clearly separated from the Interactive Pad.

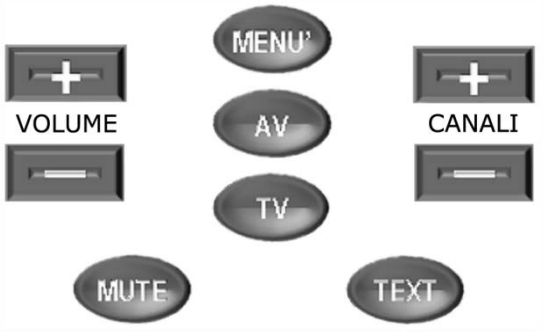


Figure 4: The TV Pad

### *6.4.9. The Player Pad*

#### 6.4.9.1. Overall Function Description

*The Player Pad, if present, is used to give interactive applications the possibility to control in an intuitive manner playback of contents received via broadband network, that is:*

- *to start/pause/resume/stop playback*

- *to skip forward/backward within the content being played back.*

## 6.5. Remote control keys detailed specifications

### *6.5.1. The Numeric Pad*

| item | Keys | Status | Function | Additional specs |
|---|---|---|---|---|
| 1 | ⓪ .. ⑨ | Mandatory | HbbTV standard | The letter text labelling has to be followed |

Table 7: The Numeric Pad

### *6.5.2. The Interactive Pad*

| item | Keys | Status | Function | Additional specs |
|---|---|---|---|---|
| 2 | Back | Mandatory | HbbTV standard | |
| 3 | Exit | Mandatory | HbbTV standard | HbbTV spec states that the EXIT key is handled by the terminal and is not passed to the application. |
| 4 | ▼▲ | Mandatory | HbbTV standard – Arrow Up / Down | |
| 5 | ◄► | Mandatory | HbbTV standard – Arrow Left / Right | |
| 6 | Ok | Mandatory | HbbTV standard | |
| 7 | | Mandatory | HbbTV standard – Red Key | |
| 8 | | Mandatory | HbbTV standard – Green Key | |
| 9 | | Mandatory | HbbTV standard – Yellow Key | |
| 10 | | Mandatory | HbbTV standard – Blue Key | |

Table 8: The Interactive Pad

### *6.5.3. The Navigation Pad*

| item | Keys | Status | Function | Additional specs |
|---|---|---|---|---|
| 11 | Info | Mandatory | This key gives access to information associated to the current channel. | *If such key is pressed while IP A/V content is playing and no broadcast A/V content is playing, it SHALL NOT display information related to the event on the broadcast channel. It SHALL either be made available to interactive applications with the code VK_INFO or it SHALL be inhibited.* |
| 12 | EPG | Mandatory | This key gives access to the Electronic Program Guide. | The labelling has to be decided by the manufacturer. |
| 13 | List | Optional | This key gives access to the receiver's service list | Audio/video, audio only and stand alone interactive services (see § 7.2.5.1). |

| item | Keys | Status | Function | Additional specs |
|---|---|---|---|---|
| 14 | Audio | Optional | This key allows the viewer to choose among different audio tracks/languages. | If such physical key is not present, the same function SHALL be implemented through some other proprietary keys or menus.<br><br>*If such key is present and it is pressed while IP A/V content is playing and no broadcast A/V content is playing, it SHALL NOT display information related to the event on the broadcast channel. It SHALL either be made available to interactive applications with the code VK_AUDIO or it SHALL be inhibited.* |
| 15 | Sub | Optional | This key allows the viewer to activate/deactivate presentation of subtitles and to select among different languages, when available. | See Subtitling specs in §8.1.3<br><br>If such physical key is not present, the same function SHALL be implemented through some other proprietary keys or menus.<br><br>*If such key is such key is present and it is pressed while IP A/V content is playing and no broadcast A/V content is playing, it SHALL NOT display information related to the event on the broadcast channel. It SHALL either be made available to interactive applications with the code VK_SUB or it SHALL be inhibited.* |

Table 9: The Navigation Pad

### 6.5.4. The TV Pad

| Item | Keys | Status | Function | Additional specs |
|---|---|---|---|---|
| 16 | Menu | Mandatory | Access to receiver's proprietary menu. Labelling is up to the manufacturer. | |
| 17 | Vol+ | Mandatory | Increase volume | |
| 18 | Vol- | Mandatory | Decrease volume | |
| 19 | CH + | Mandatory | Switch channel up of one position according to the channel list | |
| 20 | CH - | Mandatory | Switch channel down of one position according to the channel list | |
| 21 | AV | Optional | Selection of external video sources such as DVD, Gaming Consoles, … | |
| 22 | TV | Optional | This key allows the user to restore TV viewing (e.g. out from Teletext) | |

Table 10: The TV Pad

### 6.5.5. The Player Pad

| item | Keys | Status | Function | Additional specs |
|---|---|---|---|---|
| *23* |  | *Optional* | *Stop playback* | *Associated to VK_STOP virtual key event* |
| *24* |  | *Optional* | *Start playback* | *Associated to VK_PLAY virtual key event* |
| *25* |  | *Optional* | *Pause playback* | *Associated to VK_PAUSE virtual key event* |
| *26* |  | *Optional* | *Start/pause toggle* | *Associated to VK_PLAY_PAUSE virtual key event* |
| *27* |  | *Optional* | *Skip forward* | *Associated to VK_FAST_FWD virtual key event* |
| *28* |  | *Optional* | *Skip backward* | *Associated to VK_REWIND virtual key event* |

Table 11: The Player Pad

*Support of Player Pad keys, if present, in the context of linear IP services is RECOMMENDED with the behaviour specified in Annex C.*

### 6.5.6. Other Keys

| item | Keys | Status | Function | Additional specs |
|---|---|---|---|---|
| 29 |  | Mandatory | Switch on/off the receiver | This key SHOULD NOT be red. |
| 30 |  | Mandatory | Teletext (see also §9.1.1. HbbTV standard otherwise. | The labelling “Text” is recommended. |
| 31 |  | Optional | Muting the volume | Pressing this key once will mute the volume. By pressing the same key again the volume level will be restored at the previous level |

Table 12: Other keys

## 6.6. Text entry

For entering text into an application HbbTV requires either multi-tap or an equivalent method (e.g. software keyboard), where characters are input character by character in the text field.

### 6.6.1. Multi-tap key assignment

In assigning specific alphanumeric characters to single numeric pad keys, the manufacturers shall take ETSI ES 202 130 [16], page 103 table 48 "Keypad assignment for Italian“, as a guideline.

A subset of the mandatory characters is recommended to be implemented within the overall ETSI character list.

#### 6.6.1.1. Standard Characters Subset

| Key | Requirement | Subset Character Sequence |
|---|---|---|
|  | Mandatory | a b c 2 à A B C |

| Key | Requirement | Subset Character Sequence |
|---|---|---|
| def 3 | Mandatory | d e f 3 è D E F |
| ghi 4 | Mandatory | g h i 4 ì G H I |
| jkl 5 | Mandatory | j k l 5 J K L |
| mno 6 | Mandatory | m n o 6 ò M N O |
| pqrs 7 | Mandatory | p q r s 7 P Q R S |
| tuv 8 | Mandatory | t u v 8 ù T U V |
| wxyz 9 | Mandatory | w x y z 9 W X Y Z |
| — 0 | Mandatory | 0 “space” “new line” |

Table 13 : Standard Character subset

#### 6.6.1.2. Special Characters Subset

As per ETSI ES 202 130 v. 1.1.1 (2003-10), (page 103 table 48 "Keypad assignment for Italian“) all special characters have to be assigned to numeric key “1”.

| Key | Requirement | Subset Character Sequence |
|---|---|---|
| .,:;@ 1 | Mandatory | . , ; @ 1 ? ! : “ % ( ) + - / * = < > € # |

Table 14: Special Character Subset

The subset of special characters listed in the previous table has to be considered as the minimum mandatory requirement for manufacturers.

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# 7. Service Information & Channel Selection

On installation, receivers must offer the viewer all services that may be received at the current location, both via DTT and via broadband (linear IP services).

Due to the distributed nature of DTT transmissions, a receiver may be able to receive more than one instance of a particular service, which may include regional variants of a service, and must handle such an occurrence sensibly from a viewer perspective.

The services being received at a given location will change over time. To ensure that the viewer is always able to access every service currently active, the receiver must detect and reflect to the viewer any such changes with minimal viewer involvement.

Services may have an associated Channel Number. Broadcasters may use this as a marketing tool for service promotion to the viewer. Consequently, when possible, receivers should present the channels so that a numeric entry will always select the service with the corresponding Channel Number. However, viewers shall also be free to re-order and/or filter the channel list as they require.

Access to, and use of, accurate service information is essential if the viewer is to enjoy all of the content being delivered. Receivers must offer a complete list of available services and information, if available, about the current and following programmes.

## 7.1. Terrestrial services

### *7.1.1. DVB Locator*

The DVB locator is the unique identifier of a DVB service. It is composed of three elements:

- Original_Network_ID
- Transport_Stream_ID
- Service_ID

Its format is dvb://<onID>.<tsID>.<sID>[.<ctag>[&<ctag>]][;<evID>][<path>]. (The optional parameter [;<evID>] allows to identify a single event within a service.)

To ensure a harmonious use of the relevant codes, a coordinated allocation of codes and code ranges is recommended for the Italian Digital Terrestrial Television environment.

The details of the scheme adopted by Italian broadcasters is given in Annex A.

### *7.1.2. SI and PSI Information*

When possible, Italian digital terrestrial operators will respect the rules suggested by the E-Book on service information. However, a receiver specification cannot put any constraints on the broadcast signal because the receiver must be robust against erroneous or incomplete signalling and present all services whenever they are present.

Of course, receiver behaviour, in many cases will be dependent on the presence, in the signal, of supplementary signalling. In this sense support to the part of the E-Book which seeks to specify the broadcast signal is not guaranteed.

#### 7.1.2.1. Notation

The same symbols as in the E-book (# 9.1.4 [8]) are adopted for specifying the expected implementation for Broadcast or Receiver.

| Meaning | Specification applies to: | |
|---|---|---|
| | Broadcast | Receiver |
| Mandatory to broadcast – this shall be present in all broadcasts | M | |
| Mandatory to understand – receivers are required to understand and act on this item | | m |
| Conditional to broadcast – this shall be present if certain criteria are met (for example, certain signalling is required for CA controlled services) | C | |
| Recommended to broadcast – inclusion of this item improves the usefulness of broadcasts to receivers and allows them to provide better facilities to users. It is preferable for broadcasts to include this. However receivers shall be able to work correctly without this information | R | |
| Optional to broadcast – this item is allowed in broadcasts and has a defined meaning. However, receivers shall be able to work correctly without it | O | |
| Undefined to broadcast – this item is allowed in broadcasts but has no defined use within this specification. Receivers should ignore this information unless they are designed with information from other specifications that define its use | U | |
| Forbidden to broadcast – this item is not allowed in broadcasts as it may cause confusion to receivers that conform to this specification | F | |

Table 15: Symbols notation as per E-Book

#### 7.1.2.2. Program Map Table (PMT)

The descriptors possibly carried by this table at Program level are the following:

| Descriptor | Tag | Status |
|---|---|---|
| Conditional access descriptor | 0x09 | C |
| Private data specifier descriptor | 0x5F | C |

Table 16: Program descriptors (PMT)

The descriptors possibly carried by this table at Elementary Stream level are listed hereafter.

| Component | Descriptor | Tag | Status |
|---|---|---|---|
| Any | Stream identifier descriptor | 0x52 | C m |
| | Conditional access descriptor | 0x09 | C |
| | Private data specifier descriptor | 0x5F | O |
| Audio | ISO 639 language descriptor | 0x0A | C m |
| Private data (AC-3) | AC-3 descriptor | 0x6A | C m |
| Private data (EAC-3) | Enhanced AC-3 descriptor | 0x7A | C m |
| Private data (AAC) | AAC descriptor | 0x7C | C m |
| DVB Subtitles | Subtitling descriptor | 0x59 | C m |
| Teletext | Teletext descriptor | 0x56 | C m |
| SSU stream | Databroadcast_id descriptor | 0x66 | O m |
| *Video* | *AVC_video_descriptor* | *0x28* | *O m* |
| *Video* | *HEVC_video_descriptor* | *0X38* | *O m* |

Table 17: Elementary stream descriptors (PMT)

#### 7.1.2.2.1 Multiple components of the same type

The PMT may contain multiple instances of components with identical signalling. For example, multiple audio components with the same stream type, language and audio_type, or multiple video components in services providing multi-angle viewing (and single audio).

In this case the receiver shall select as default component the one with the lowest PID among those of the same type.

However, all the components shall be presented for manual selection when requested by the user. As another example, multiple interactive services listed inside an AIT table shall be presented in ascending order from the lowest application_ID, and if multiple AIT are referenced in one PMT, their order shall also be preserved.

#### 7.1.2.2.2 HD-specific elementary stream types

*Further to the stream types*

- 0x02 for MPEG-2 or MPEG-1 constrained parameter video streams
- 0x03 for MPEG-1 audio streams
- 0x05 for MPEG-2 TS private_sections
- 0x06 for PES packets containing private data
- 0x0B for MPEG-2 DSM-CC type B streams

*whose support was already required for SD receivers by DGTVI's D-Book [36], the following stream_type values SHALL also be supported in the scope of this HD-Book:*

- *0x11 for MPEG-4 AAC and MPEG-4 HE AAC packetized elementary streams*
- *0x1B for H.264/AVC video streams*
- *0x24 for HEVC video streams*

*The value of stream_type for an Enhanced AC-3 elementary stream will be 0x06 (indicating PES packets containing private data), same as for AC-3.*

#### 7.1.2.2.3 Supplementary Audio

For TV-broadcasting applications, noticeably public service broadcasting, there is often a requirement for commentary or narration audio services to provide for different languages or Visually Impaired or Hearing Impaired audiences.

#### 7.1.2.2.4 DVB solution

DVB solution encompasses both receiver-mixed and broadcast-mixed Supplementary Audio. Relevant signalling specifications are contained in new Annex to latest [9] revisions.

#### 7.1.2.2.5 Enhanced AC-3 solution

*Compliance with the behaviour specified in [9] §6.2.2.2 is required.*

#### 7.1.2.2.6 AVC_video_descriptor

*This descriptor is used to signal the presence of the frame packing arrangement supplemental enhancement information (SEI) message in the AVC video stream. Thanks to this message the receiver will be able to recognize [57]:*

- *the frame-compatible video format used, or currently in use, for the 3DTV service;*
- *format switches within a running Frame-Compatible 3DTV service (between 2 3DTV formats, to/from a 3DTV from/to a 2D HD format).*

*The detailed usage of the frame packing arrangement SEI message for Frame-Compatible 3DTV services is specified normatively in Annex H of [9].*

#### *7.1.2.2.7 HEVC_video_descriptor*

*This descriptor is used to signal the presence of the frame packing arrangement supplemental enhancement information (SEI) message in the HEVC video stream. Thanks to this message the receiver will be able to recognize [57]:*

- *the frame-compatible video format used, or currently in use, for the 3DTV service;*
- *format switches within a running Frame-Compatible 3DTV service (to/from a 3DTV from/to a 2D HD format).*

*The detailed usage of the frame packing arrangement SEI message for Frame-Compatible 3DTV services is specified normatively in Annex H of [9].*

### 7.1.2.3. Network Information Table (NIT)

The descriptors possibly carried by this table in first loop are the following:

| Descriptor | Tag | Status | |
|---|---|---|---|
| | | Actual | Other |
| Network_name_descriptor | 0x40 | M m | O m |
| Multilingual_network_name_descriptor | 0x5B | O m | O m |
| Linkage_descriptor | 0x4A | C | C |
| Private_data_specifier_descriptor | 0x5F | C | C |
| *URI_linkage descriptor* | *ext(0x13)* | *O m* | *O* |

Table 18: Network descriptors (NIT first loop)

The descriptors possibly carried by this table in second loop are the following:

| Descriptor | Tag | Status | |
|---|---|---|---|
| | | Actual | Other |
| Terrestrial_delivery_system_descriptor | 0x5A | M m* | O |
| Frequency_list descriptor | 0x62 | R | R |
| Service_list_descriptor | 0x41 | R | R |
| Private_data_specifier_descriptor | 0x5F | C | C |
| Logical_channel_descriptor | 0x83 | O m | O |
| *HD simulcast descriptor* | *0x88* | *O m* | *O m* |
| T2_delivery_system_descriptor | ext(0x04) | M m | O |
| *Receiver shall ignore the majority of the fields of this descriptor, see below §7.1.2.3.2 | | | |

Table 19: Transport stream descriptors (NIT second loop)

#### *7.1.2.3.1 URI linkage descriptor*

*This descriptor MAY be used for discovering a list of linear IP services (see below §7.2).*

*The URI_linkage_descriptor includes a parameter, the min_polling_interval, that represents the minimum time, in intervals of two seconds, the receiver should poll this URI for possible updates.*

#### 7.1.2.3.2 Terrestrial delivery system descriptor

Receivers may use the modulation parameters in the terrestrial_delivery_system_descriptor as a recommendation when trying to tune to a multiplex but the receiver shall always be able to detect the modulation from the transmission itself (e.g. assisted by TPS bits).

MFN network may include repeaters (or channel translations can be performed in MATV systems): the receiver shall ignore the “centre_frequency” specified in the terrestrial delivery system descriptor. In other words the receiver shall select the service in a DVB-T channel according to the frequency used during the tuning procedure, ignoring the value contained in the NIT.
The receiver should take into account the
- other_frequency_flag (inside the terrestrial_delivery_system_descriptor)

Receiver shall ignore the “bandwidth”, “priority”, “constellation”, “hierarchy_information”, “code_rate”, “guard_interval” and “transmission_mode” values in the terrestrial_delivery_system_descriptor of the NIT.

If a change occurs in the “network_id” in the NIT, during transmission, the receiver shall ignore it and continue to present the services already in the list and not delete them.

If a change occurs in the “network_name_descriptor” the receiver shall ignore it and continue to present the services already in the list and not delete them

#### 7.1.2.3.3 T2 Delivery System Descriptor

T2_delivery_system_descriptor is signalled in the extension_descriptor (Tag extension value 0x04).

The T2-IRD SHALL uses the system parameters in the T2_delivery_system_descriptor to determine the mapping between original_network_id/network_id/transport_stream_id and T2_system_id/plp_id.

The T2-IRD SHOULD uses the other system parameters in the T2_delivery_system_descriptor as a recommendation when trying to tune to a multiplex. The T2-IRD SHOULD, however, always be able to detect these system parameters from the transmission itself (i.e. assisted by L1 signalling).

Operators can broadcast the same transport stream in the same network using different system parameter settings, reflected in a different T2_system_id. This allows for optimization of the network coverage in frequency planning involving SFN and MFN combination networks.

#### 7.1.2.3.4 Other_frequency_flag

The terrestrial_delivery_system_descriptor may signal the use of possible alternative frequencies through the other_frequency_flag. According to the SI Guidelines [25], this flag may be used (inter alia) to advise the receiver that an identical multiplex may be receivable on other centre frequencies. The receiver must always be able to receive all the available services in the RF channels.

If the same service is available on two different RF channels, both were tuned (with the automatic or manual scan procedure), and both are available to the user.

Support by receivers of this flag is OPTIONAL. It is expected that broadcasters in Italy will not use this flag.

#### *7.1.2.3.5 Logical Channel Descriptor*

The logical channel descriptor provides a default channel number label for services. This information is quasi-static. The logical channel descriptor may be inserted once in the second descriptor loop of the NIT. **The logical channel number is not necessarily unique within the same original_network_id** (except when its value is zero) **but may be re-used for regional variants of a service or for local services with strictly not overlapping coverage**. Hence the number is not unique within the original network.

**The logical channel number does not take into account the service type, i.e. all service types share the same number space.**

**The logical channel number does not take into account the transmission standard, i.e. services transmitted on DVB-T and DVB-T2 share the same numbering space.**

| Syntax | No. of bits | Type |
|---|---|---|
| `logical_channel_descriptor{` | | |
| `descriptor_tag` | 8 | uimsbf |
| `descriptor_length` | 8 | uimsbf |
| `for (i=0; i<N; i++){` | | |
| `service_id` | 16 | uimsbf |
| `visible_service_flag` | 1 | bslbf |
| `reserved` | 5 | bslbf |
| `logical_channel_number` | 10 | uimsbf |
| `}` | | |
| `}` | | |

Table 20: Syntax of the logical channel descriptor

**Descriptor_tag:** This shall be assigned to be 0x83.

**Service_id:** This is a 16 -bit field which serves as a label to identify this service from any other service within the network. The service_id is the same as the program_number in the corresponding program_map_section. Services shall be included irrespective of their running status.

**Visible_service_flag:** When set to ‘1’, this 1-bit field indicates that the service is normally visible and selectable (subject to the service type being suitable, etc.) via the receiver service list. When set to ‘0’ this indicates that the receiver is not expected to offer the service to the user in normal navigation modes. However, the receiver should provide a mechanism to access these services (for example, by direct entry of the logical channel number).

See also Receiver rules. Support by receivers of the visible_service_flag is MANDATORY.

**Reserved:** All “reserved” bits shall be set to ‘1’.

**Logical_channel_number:** This is a 10 -bit field which indicates the broadcaster preference for ordering services. Its use is defined in the following table:

| logical_channel_number | Description |
|---|---|
| 0 | Service not suitable for selection by the user a) |

| logical_channel_number | Description |
|---|---|
| 1 - 999 | logical_channel_number |
| 1000 - 1023 | rfu – not usable |
| a ) For example, the value zero may be used for data services only intended for selection from interactive applications or for firmware download services, etc. | |

Table 21: Logical channel number

Any service with LCN=0 shall be ignored.

See also Receiver rules.

#### *7.1.2.3.6 HD Simulcast Logical Channel Descriptor*

*The HD Simulcast Logical Channel Descriptor provides a means to override the default channel number label of services for an HD receiver. This information is quasi-static.*
*The HD simulcast logical channel descriptor may be inserted in the second descriptor loop of the NIT. The descriptor may appear more than once in this location.*

*The constraints on uniqueness are the same as those for the logical channel descriptor.*

| Syntax | No. of bits | Type |
|---|---|---|
| *HD_simulcast_descriptor{* | | |
| *descriptor_tag* | *8* | *uimsbf* |
| *descriptor_length* | *8* | *uimsbf* |
| *for (i=0; i<N; i++){* | | |
| *service_id* | *16* | *uimsbf* |
| *visible_service_flag* | *1* | *bslbf* |
| *reserved* | *5* | *bslbf* |
| *logical_channel_number* | *10* | *uimsbf* |
| *}* | | |
| *}* | | |

Table 22: Syntax of the HD simulcast logical channel descriptor

**Descriptor_tag:** *This shall be assigned to be 0x88.*

**Service_id:** *This is a 16 -bit field which serves as a label to identify this service from any other service within the network. The service_id is the same as the program_number in the corresponding program_map_section. Services shall be included irrespective of their running status.*

**Visible_service_flag:** *When set to '1', this 1-bit field indicates that the service is normally visible and selectable (subject to the service type being suitable, etc.) via the receiver service list. When set to '0' this indicates that the receiver is not expected to offer the service to the user in normal navigation modes. However, the receiver should provide a mechanism to access these services (for example, by direct entry of the logical channel number).*

*See also Receiver rules. Support by receivers of the visible_service_flag is mandatory.*

**Reserved:** *All "reserved" bits shall be set to '1'.*

**Logical_channel_number:** *This is a 10-bit field which indicates the broadcaster preference for the ordering of services. This descriptor shall only be interpreted by receivers that are*

*able to decode an advanced codec HD digital television service. The channel number label assignment defined by this descriptor overrides the channel number label assignment defined by the Logical Channel Descriptor that is located in the same network_id. The rules for the set of channel number labels used by this descriptor is the same as the rules for the set of channel number labels*
*used by the Logical Channel Descriptor.*
*In the case where this descriptor assigns to a service (service A) a channel number label which is already assigned to another service (service B) (perhaps by the Logical Channel Descriptor), the receiver shall treat the original service (service B) as having no assigned channel number label and assign one automatically in the normal manner.*
*This descriptor is intended to be used for HD services broadcast in simulcast with the same service in SD so that the HD service appears at the primary channel number label on HD capable receivers while the SD service appears at that label for SD-only capable receivers.*

*Expected receiver behaviour in presence of HD_simulcast_LCN_descriptor is outlined in the following flow chart.*

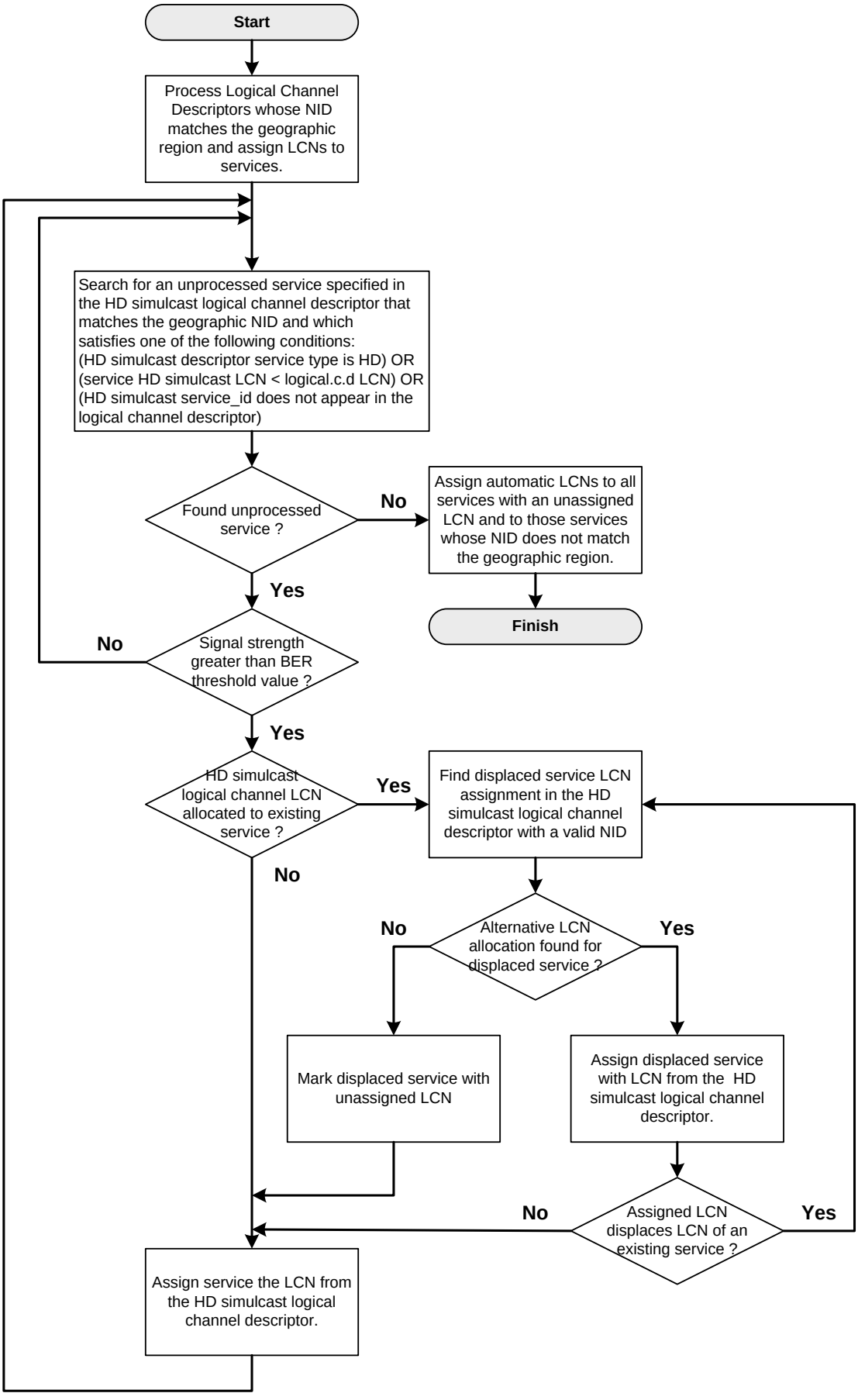


Figure 5: HD_simulcast_LCN operation

#### 7.1.2.4. Bouquet Association Table (BAT)

Even though BAT has been experimentally used for some time in Italy for running applications with a domain defined across multiple services and/or multiple connections within a bouquet, receivers can ignore it.

#### 7.1.2.5. Service Description Tables (SDT)

The descriptors possibly carried by this table are the following:

| Descriptor | Tag | Status | |
|---|---|---|---|
| | | Actual | Other |
| Service_descriptor | 0x48 | M m | O m |
| Component_descriptor | 0x50 | C m | C m |
| CA_identifier_descriptor | 0x53 | C m | C m |
| Private_data_specifier_descriptor | 0x5F | C | C |
| Preferred_name_list_descriptor | 0x84 | O | O |
| Linkage_descriptor | 0x4A | O m | O m |

Table 23: Service descriptors

In presence of a CA_Identifier_Descriptor, the receiver shall always try to present the service to the end user. In case the service is effectively scrambled, and the relevant CA system is not present, the receiver shall present an error message (see 7.5.1.2).

The preferred_name_list_descriptor, as defined in [8], provides a list of alternative names, and name identifiers, for the service. This information is quasi-static.

*New component types have been defined for stream content_type 0x05 (AVC/H.264) to signal in the component_descriptor frame-compatible video component formats. Those required by this specification are:*

- *H.264/AVC plano-stereoscopic frame compatible high definition video, 16:9 aspect ratio, 25 Hz, Side-by-Side (component_type code 0x80);*
- *H.264/AVC plano-stereoscopic frame compatible high definition video, 16:9 aspect ratio, 25 Hz, Top-and-Bottom (component_type code 0x81).*

*It should be noted that no new component types have been defined to signal the usage of frame-compatible formats with HEVC, signalling thereof being provided by coupling the HEVC service_type with a suitable EIT component descriptor (see §7.1.2.6.1).*

##### *7.1.2.5.1 Service Types*

Receivers shall only list a service in their service selection interfaces where the service is of a type, as declared in the service_type value in the Service Descriptor, which the receiver is able to present to the user or to a receiver interface.

NB: Users may be confused or frustrated if the receiver presents for selection services that are not decodable by the receiver (such HD services on an SD receiver) or are not intended for user selection (such as receiver firmware update broadcasts).

Receivers are required to support at least the following service types:

service_type = 0x01, digital television service
service_type = 0x02, digital radio sound service (MPEG-1 Layer 1 or 2 audio)
*service_type = 0x0A, advanced codec digital radio sound service*
*service_type = 0x16, advanced codec SD digital television service*

*service_type = 0x19, advanced codec HD digital television service*
*service_type = 0x1C, advanced codec frame-compatible plano-stereoscopic HD digital television service*

*The following signalling SHALL be present for HEVC HD services in accordance with [10]*

*service_type = 0x1F*
*stream_content = 0x9*
*stream_content_ext = 0x0*
*component_type = 0x00 (HEVC Main Profile HD, 50 Hz) or 0x01 (HEVC Main 10 Profile HD, 50 Hz)*

*Receivers supporting HEVC SHALL interpret and correctly react to the above signalling (service_type, stream_content, stream_content_ext, component_type).*

> *NOTE: In the future, the same service_type may be used for future formats which may not be supported by the HEVC receiver described in this version of specification. For this reason, it is essential that receivers interpret the four fields described above.*

*According to DVB SI [10], service_type=0x01 should be used for MPEG-2 SD digital television service. However, it may also be used for services using other encodings, including encodings that have a specific entry, e.g. advanced codec HD digital television service. That doesn't apply to services using HEVC video coding which SHALL be explicitly and unambiguously signalled as stated above.*

*A service, as identified by its DVB triplet, will exclusively be either SD or HD.*

Support for other service types (for example service_type = 0x06, mosaic service) is optional.

#### *7.1.2.5.2 Running status*

Receivers are required to support at least the following values and behaviours for the running_status in SDT:

running_status = 4, running -> normal behaviour
running_status = 1, not running -> display banner with the following exception

If a linkage descriptor with linkage type 0x05 (service replacement service) is present in SDT for a given service, the receiver SHALL automatically select the replacement service, if selectable, instead. The receiver SHALL listen to updates of the running_status value (from running to not running or from not running to running) of the given service in SDT, automatically selecting the replacement service or the service itself, if selectable.

### 7.1.2.6. Event Information Table (EIT)

#### *7.1.2.6.1 Event Information Descriptors*

The EIT can carry the following descriptors to meet the requirements of EN 300 468 [10] and TR 101 211 [19]:

| Descriptor | Tag | Status | | | |
|---|---|---|---|---|---|
| | | Present/Following | | Schedule | |
| | | Actual | Other | Actual | Other |
| Linkage descriptor | 0x4A | O m | O m | C | C |
| Short event descriptor | 0x4D | M m | M m | O m* | O m* |

| Descriptor | Tag | Status | | | |
|---|---|---|---|---|---|
| | | Present/Following | | Schedule | |
| | | Actual | Other | Actual | Other |
| Extended event descriptor | 0x4E | C m | C m | O | O |
| Component descriptor | 0x50 | M | M | O | O |
| CA identifier descriptor | 0x53 | C | C | C | C |
| Content descriptor | 0x54 | R | R | R | R |
| Multi lingual component descriptor | 0x5E | O | O | O | O |
| Parental rating descriptor | 0x55 | O m | O | O | O |
| Time shifted event descriptor | 0x4F | F | F | F | F |
| Private data specifier descriptor | 0x5F | C | C | C | C |
| PDC descriptor | 0x69 | C | C | C | C |
| Preferred name identifier descriptor | 0x85 | O | O | O | O |
| * Mandatory only if no other EPG than the one based on SI data is available on the receiver | | | | | |

Table 24: Event Information Descriptors

The preferred_name_identifier_descriptor, as defined in [8], may be used in the EIT to identify the preferred service name at the time of an event and so allows a schedule of service names.

*The "special characteristics" content class in the content_descriptor has been extended to include the following event characteristic for Frame-Compatible 3DTV events [57]:*

- *Stereoscopic (content_nibble_level_2 code 0x4).*

*When using a Frame-compatble format in a HEVC service, the component descriptor as defined in Table I.3 in [46] can be used*

- *plano-stereoscopic top and bottom (TaB) frame-packing (0xB, 0xF, 0x03)*

*Operators are thus able to highlight events broadcast in a Frame-Compatible 3DTV format in the EIT. Receivers may use this information to highlight such events in the EPG.*

#### *7.1.2.6.2 Carriage of EIT*

It is expected that network operators carry data for current and next events concerning the services they are broadcasting, on a multiplex per multiplex basis. This will be done within the ability of the content providers to transfer the relevant data to the network operator.

#### *7.1.2.6.3 Cross Carriage of EIT*

It is expected that national network operators will cross carry EIT data, at least for national services. Similar agreements may exist with regional/local network operators.

The policy of allocation of TS_ID and S_ID on mixed national or regional networks may influence the carriage of cross-SI among a given number of operators. Therefore it is extremely important that network operator follow the DGTVi recommended procedures for ID allocation and use (see Annex D).

A basic requirement when an operator carries EIT p/f of other operators in EIT_other tables is that such functionality shall not have excessive impact on bandwidth or complexity of operation. This can be achieved e.g. by limiting the number of variants when a national network partially splits into regional programming.

#### 7.1.2.7. Summary of mandatory tables

| Table | Actual | Other |
|---|---|---|
| Program association table | M m | N/A |
| Program map table | M m | N/A |
| Conditional access table | C | N/A |
| Network information table | M m | O m |
| Bouquet association table | U | N/A |
| Service description table | M m | M m |
| Event information table present/following | M m | M m |
| Event information table schedule | O m* | O m* |
| Time and date table | M m | N/A |
| Time offset table | R m | N/A |
| Running status table | U | N/A |
| * Mandatory only if no other EPG than the one based on SI data is available on the receiver | | |

Table 25: List of mandatory tables

#### 7.1.2.8. Private Data

When private descriptors are present in a broadcast, a private data specifier descriptor SHOULD be used (cf. EN 300 468) to identify the definer of the private descriptor.

For the Logical Channel Descriptor, the private data specifier value used in the E-Book, as registered in ETSI TR 101 162, shall be used; it is the one registered for EACEM (then EICTA, DIGITALEUROPE today).

The following table lists this value and the other private SI items that are defined within its scope.

| Organisation/ specification | PDSD | Private SI information | Value | Type |
|---|---|---|---|---|
| EACEM | 0x00000028 | Eacem stream identifier descriptor | 0x86 | Descriptor tag |
| EACEM | 0x00000028 | Logical channel descriptor | 0x83 | Descriptor tag |
| EACEM | 0x00000028 | Preferred name list descriptor | 0x84 | Descriptor tag |
| EACEM | 0x00000028 | Preferred name identifier descriptor | 0x85 | Descriptor tag |
| *EACEM* | *0x00000028* | *HD simulcast descriptor* | *0x88* | *Descriptor tag* |

Table 26: Private SI recognised in the E-Book

## 7.2. Linear IP services

### *7.2.1. Format*

*As already introduced in Chapter 6, linear IP services compliant with the present specification SHALL comply with DASH Live Profile, as further profiled in [69] and [6].*

*Generally speaking, a linear IP service could convey whatever a DASH manifest could actually do (free contents, protected contents, subtitles, multiple audio languages, …).*

### *7.2.2. Signalling*

*For the purpose of notifying compliant receivers about linear IP services made available within the current (broadcast) platform, the Online SDT (OSDT) is adopted, as defined in the context of CIPlus 1.4 [37].*

*In particular, through OSDT receivers can associate to each linear IP service*

- *A service name and a domain name*
- *The URL where their DASH manifest can be found*
- *One or more countries where the service is applicable*
- *A number equivalent to broadcast LCNs*

*For other PSI/SI-equivalent information associated to linear IP services, like service components (e.g. multiple audio/subtitle languages), their encryption status and event metadata (e.g. name of the event, start time, duration, parental rating) receivers will instead rely on DASH MPD information elements.*

#### 7.2.2.1. OSDT profile

*For application to linear IP services compliant with this specification, the following profiles of the OSDT schema defined in [37] apply[14]:*

| Element/attribute | Description | Status |
|---|---|---|
| *SubRegionType* | *A type used to provide the name of the sub-region.* | *O m* |
| *Region* | *The name of the sub-region. Multiple elements of this type may be provided as long as they have different languages* | *O m* |
| *RegionListType* | *A type used to define the region and provide the region name.* | *M m* |
| *PrimaryRegion* | *The details of the region, defined in a hierarchical manner starting from the primary region.* | *M m* |
| *CountryCodes* | *The list of countries that make up the region which is further defined by the PrimaryRegion element.* | *M m* |
| *TargetRegionType* | *A type used to provide the country and region within the country where the service is intended to be received. Where this is intended to be equivalent to the target region descriptor, the use of sub-regions shall be limited to two levels (i.e. primary regions containing sub-regions which contain sub-regions).* | *M m* |
| *RegionList* | *The list of regions within the countries.* | *M m* |
| *AccessibleOutOfRegion* | *A flag indicating whether the service should be accessed when the Host is not in one of the listed regions.* | *O* |

Table 27: Profile for OSDT's SubRegionType

| Element/attibute | Description | Status |
|---|---|---|
| *ServiceLocationType* | *A type used to provide the location information for the service along with DRM information and audio/video information.* | *M m* |
| *DRMControlInformation* | *Used to provide DRM information, including the DRM system ID and other metadata, for this version of the service. At most one element may be present.* | *C m* |
| *ContentAttributes* | *The attributes of the audio, video, captioning and signing of this version of the service.* | *O* |
| *IPMulticastAddress* | *Signals the use of IGMP to access the service and provides the* | *U* |

[14] For the "Status" column the same notation introduced in §7.1.2.1 for broadcast is used

| Element/attibute | Description | Status |
|---|---|---|
| | *transport address and other parameters at which the service may be accessed.* | |
| *RTSPURL* | *Signals the use of RTSP to access the service and provides the URL at which the service description may be accessed.* | *U* |
| *UriBasedLocation* | *Provides the URI where the service is located, where the target of the URI has the MIME type as provided in the contentType attribute.* | *M m* |
| *priority* | *The priority of this ServiceLocationType element relative to other ServiceLocationType elements for the service.* | *O m* |
| *ExtendedURIType* | *A type used to provide a URI with additional information.* | *M m* |
| *contentType* | *The MIME type of the object identified by the URI. Receivers shall support "application/dash+xml". ExtendedURIType elements with different values may be ignored.* | *M m* |
| *URI* | *The URI providing the location of the service* | *M m* |
| *ContentAttributesType* | *A type used to provide the audio, video and other attributes of the service.* | *O* |
| *AudioAttributes* | *The audio attributes of the service.* | *O* |
| *VideoAttributes* | *The video attributes of the service.* | *O* |
| *CaptionLanguage* | *The language of the captions on the service.* | *O* |
| *SignLanguage* | *The language of the signing with the service..* | *O* |
| *LCNType* | *A type used to provide the logical channel number for the service.* | *O m* |
| *LCN* | *The logical channel number. The semantics for this attribute are the same as for the logical_channel_number field in §7.1.2.3.5* | *O m* |
| *subscribed* | *A flag indicating whether the user has subscribed to this service or not. When false, the device can assume that it will not be able to present this service. If this attribute is not provided, the subscription status is not known.* | *U* |
| *selectable* | *A flag indicating whether the device should allow the service to be selected via direct numerical entry of the logical channel number. This flag is only interpreted when the visible flag is set to false. When set to true, the flag indicates that the hidden service is selectable by direct entry of the logical channel number; when set to false, then the hidden service is not directly selectable by the user (but may be selectable by LCN from an application environment).* | *U* |
| *visible* | *A flag indicating whether the device should include this service in any service list or EPG presented to the viewer. When set to true, this flag indicates that the service is normally visible via the Host service or channel list and EPG etc. When set to false, this indicates that the receiver is not expected to offer the service to the user in normal navigation modes but the receiver shall provide a mechanism to access these services by direct entry of the logical channel number, depending on the setting of the selectable flag.* | *O m* |
| *IPServiceType* | *A type used to provide the details of the service.* | *M m* |
| *UniqueIdentifier* | *The unique ID of the service. This ID should never be changed for a service, even if all other parameters of the service are changed. The child attribute DomainName, if omitted, shall take the value of the domain from where this file was located.* | *M m* |
| *DVBTriplet* | *The DVB triplet that can be used to refer to this service, even if the service is not delivered in a TS.*<br>*Note: If this triplet matches the triplet of another service, it can be* | *M m* |

| Element/attibute | Description | Status |
|---|---|---|
| | *assumed that the services editorially carry the same content.* | |
| *ServiceLocation* | *The location(s) where the A/V content for the service may be found. If multiple elements of this type are present, the one with the highest value of the priority attribute has the highest priority* | *M m* |
| *LCN* | *The logical channel number of the service.* | *O m* |
| *TargetRegions* | *The target regions for the service where the service is intended to be received.* | *M m* |
| *ServiceName* | *The name of the service. Multiple elements of this type may be provided as long as they all have different lang attributes.* | *M m* |
| *ApplicationLocation* | *The location of the XML AIT file where the application associated with the service may be found, as defined in TS 102 809 [34].* | *O m* |
| *ServiceGenre* | *The genre of the service.* | *O* |
| *ServiceType* | *The service type, as defined in EN 300 468 [10].* | *O* |
| *ContentAttributes* | *The attributes of the content for the service* | *O* |
| *BCG* | *The details of a broadband content guide carrying metadata for this service.* | *O* |
| *IPServiceListType* | *A type to list all the available services and the BCG covering these services.* | *M m* |
| *IPService* | *The details of the services.* | *M m* |
| *BCG* | *The details of a broadband content guide carrying metadata for this service* | *O* |
| *Version* | *The version number of this parent element.* | *M m* |

Table 28: Profile for OSDT's ServiceLocationType

#### 7.2.2.2. Programme metadata

*Content programme metadata for linear IP services are delivered in the MPD by using both "native" DASH elements, like @presentationTime and @duration respectively for event start time and duration [60], and EventStreams as specified in section 9.1.2 of DVB-DASH [69].*

*The TV-Anytime BroadcastEvent/InstanceDescriptionType used therein for this purpose is profiled as follows [49]:*

| Element/attribute | Description | Status |
|---|---|---|
| *InstanceDescriptionType* | *Complex type used to describe programme instances* | *M m* |
| *Title* | *A title of the programme.* | *M m* |
| *Synopsis* | *A textual description of this instance.* | *M m* |
| *Genre* | *A genre for the programme.* | *O* |
| *PurchaseList* | *A list of purchase items.* | *U* |
| *CaptionLanguage* | *Describes one language of the caption information included with the programme. The type of the caption information associated with the programme is denoted by the closed attribute. Closed captions can be turned on or off by the user, while open captions (or subtitles) are part of the picture itself and remain visible.* | *U* |
| *SignLanguage* | *Specifies the sign language provided for the multimedia content and, optionally, qualifies the use of signing as a primary language and/or as a translation of the spoken dialogue.* | *U* |

| Element/attribute | Description | Status |
|---|---|---|
| *ParentalGuidance* | *A parental rating code for this instance. Defined as an TV-Anytime extension to the MPEG-7 datatype, ParentalGuidanceType (see clause 9.2.3 of ISO/IEC 15938-5 [50] for a detailed specification). For parental rating the "urn:dvb:iptv:rating:2014" scheme is used, where the "id" is a decimal number representing the minimum recommended age encoded as per ETSI EN 300 468 (e.g. age 5 is encoded with an "id" of "2") [10]* | *C m* |
| *AVAttributes* | *Technical (audio-visual) attributes about this particular instance.* | *U* |
| *MemberOf* | *A list of groups of which the programme is a member.* | *U* |
| *OtherIdentifier* | *An additional optional identifier to identify the instance.* | *U* |
| *RelatedMaterial* | *A relation attribute to signal a variety of relationships between content publications.* | *U* |

Table 29: Profile for TV-Anytime BroadcastEvent/InstanceDeclarationType

*The following table summarizes the essential elements a receiver will use to populate info and channel banners for linear IP services, comparing them with the corresponding elements used on broadcast ones (in parenthesis where they are located):*

| *Information* | *Broadcast* | *IP* |
|---|---|---|
| *Service name* | *service_name (SDT)* | *ServiceName (OSDT)* |
| *Event name* | *event_name (EIT)* | *Title (MPD)* |
| *Event start time* | *start_time (EIT)* | *@presentationTime (MPD)* |
| *Event duration* | *duration (EIT)* | *@duration (MPD)* |
| *Event parental rating* | *rating (EIT)* | *ParentalRating (MPD)* |
| *Event description* | *Item_description (EIT)* | *Synopsis (MPD)* |

Table 30: Basic elements used to populate info and channel banners

### *7.2.3. Discovery*

*Receivers SHALL discover the URL of one or more OSDT files (if any) by looking at on air NITs for uri_linkage_descriptor with linkage_type=0x00 [10].*

*Based on private agreements between manufacturers and platform/service providers, outside the scope of this document, one or more "well-known URLs" MAY also be used to download OSDT(s).*

*Other possible OSDT(s) discovery mechanisms (e.g. based on DNS like RadioDNS Hybrid Radio) are left for further study.*

### *7.2.4. Use cases for OSDT discovery*

*Based on the OSDT discovery mechanisms introduced above, several use cases can be envisaged:*

- *A single platform-wide OSDT is maintained by an independent entity at a given URI. Such URI could be either embedded in receivers or broadcasted in the NIT of one or more multiplexes, to maximize its reception probability*
- *Same as above for national linear IP services, plus one or more OSDTs for local ones*
- *Same as above plus one or more OSDTs defined by Pay TV Operators with a CIplus 1.4 CICAM [37]*
- *Different (partial) OSDT's URIs are signalled by the various terrestrial operators in their NITs, much like they do for broadcast channels*

*Even though the present specification is expected to support any of above uses cases and more, for the first experimental phase of linear IP services receivers may assume that a single OSDT will be signalled via the URI_linkage_descriptor, possibly repeated on more muxes/NITs.*

## 7.3. LCN operation

The role of the LCN is to enable user presentation of service numbers in a convenient and familiar form.

To avoid conflicting allocation of LCNs:

- The logical_channel_number should be unique across all the networks that cover the same geographical region.
- The same logical channel number should be reused only in non-adjacent regions,
- Regional variants of a service may nevertheless use the same logical channel number.

Receivers need to have a mechanism for handling conflicting LCN allocations either within the same country or on the borders of confining countries (see below).

### *7.3.1. Network operator rules*

Network operators and content providers operating within Italy have elected to choose a service numbering scheme between them, in collaboration with the appropriate coordinating authorities.

This specification defines the logical channel number concept for conveying such service numbering information to receivers. Network operators should obey the following specification rules in order for receivers to be able to properly operate.

Logical channel numbers allocated should be usable directly as service numbers in a receiver.

Services with the same triplet (original_network_id/transport_stream_id/service_id) shall have the same logical_channel_number. Within the scope of one network (as defined by the network_id), logical channel numbers shall be allocated uniquely.

When defining regional variants of a service, the same logical_channel_number may be used (for example in neighbouring networks). This facilitates defining a consistent and compact national/regional/local channel numbering scheme, as well as indicating to the receiver that services with the same logical_channel_number are similar (regional variants).

Proper usage for their networks by Italian and confining broadcasters of NIT network_id values in the ranges officially assigned by DVB to the respective DTT networks (see Annex D) allows receivers to understand which LCNs belong to which country and then to give priority in case of conflicts to those from the country selected at first installation time.

#### 7.3.1.1. Multiples LCNs for a single service

Network operators and/or service providers MAY allocate up to four LCNs to a single service. This allows the service to be identified and associated with other services according to different criteria, such as local service, with pay elements, belonging to a specific bouquet and being of specific thematic content.

Only handling first LCN per service is mandatory.

#### 7.3.1.2. Invisible services

It is recommended to allocate high service numbers to services marked as invisible to avoid accidental collision of service numbers with those of visible services when they are being automatically or manually reallocated.

#### 7.3.1.3. Service number zones

The service numbers are divided into two zones:

1- 99: the Preferences Zone
100-999: the Assignment Zone

Service numbers (LCNs) may be pre-assigned in both zones.

Furthermore, a specific range, the Main Overflow (or “Garbage Collector”), has been defined to host services without LCN and services which have lost LCN conflict for another position.

The Main Overflow occupies service numbers 850 to 999. In case Main Overflow space would get filled up, free positions from 849 backwards SHALL be used.

### *7.3.2. Receiver rules*

Receivers SHALL provide an automatic service numbering facility on the basis of logical channel numbers with the rules set out below.

It SHOULD be possible for the user to select, in the set up menu, the possibility to switch off and on this automatic ordering possibility. Default setting SHALL be ON.

#### 7.3.2.1. General rules

The receiver SHALL be able to associate with one service (i.e. with a unique triplet) at least the first logical channel number set by the broadcaster in the LC descriptor associated with that service. Support of other possible LCNs (up to 4) associated to the same service is OPTIONAL.

When a viewer uses the channel up-down arrows, the receiver SHALL skip all service numbers which are not allocated or are allocated to “invisible” services.

In the following sections a comprehensive specification for LCN handling by receivers is provided. This specification is meant to

- Accommodate possible LCN conflicts while minimizing the risk of discarding potentially useful services thanks to the reservation of a “safe” overflow range
- Leave the user the ultimate freedom to override any broadcaster-defined LCN
- Cope with network evolution (e.g. new services on-air; LCNs introduced later for services already on-air)
- Cope with possible (likely) cross-border LCN conflicts
- Seamlessly integrate in a single ordered list both conventional broadcast and linear IP services

It is offered to manufacturer just as a reference implementation. Manufacturers are free to provide their own alternate implementations provided that the above principles are anyway met.

#### 7.3.2.2. Definitions

##### *7.3.2.2.1 Scan List*

This is the full list of services created on the basis of the services found by doing a frequency scan. It shall include the Logical Channel Number(s) requested by each service.

#### *7.3.2.2.2 Service List*

This is the ordered list based on the requested LCNs and after the resolution of the eventual conflicts in the requests. The only user intervention allowed to this list is during resolution of conflicts.

#### *7.3.2.2.3 Master User List*

Initially, if the user has chosen automatic channel ordering at (re)installation time, equal to the Service List (with maybe the exception of invisible services – see below), this list includes subsequent manual modifications by the user.
This is the default list of services that is used by the user.

#### *7.3.2.2.4 User Favourite List(s)*

It is recommended that manufacturers implement some form of “favourite channel” list(s) in which the user has full control over channel adding, deleting, ordering and numbering, including the possibility to leave out services even when they have been allocated a valid service number.

### 7.3.2.3. Logical channel number zero

Services associated to logical channel number 0 should be disregarded as part of the process below (irrespective of the value of the visible_service_flag). These services are not intended to be presented as part of the viewer’s service list. These services are not intended to be selectable by viewers.

### 7.3.2.4. Invisible services

- Receivers shall support a “default” mode in which they will not show services marked “invisible” in their user service list or selectable in normal P+/P - browsing.
- The receiver shall ignore the presence of “invisible” services when (re-) allocating services to service numbers requested by “invisible” services.
- Receivers shall support a mode (for example as a service mode or as an installation option) in which it will allow direct selection of all services (irrespective of being marked invisible) by the user. This mode may display all services also as part of the Service List in this mode.
- It is a manufacturer option to combine the two modes mentioned above, by allowing direct selection of “invisible” services while not showing them as part of the Master User List.
- Usually, “invisible” services should not be allocated a Logical Channel Number, and thus should be positioned in the Overflow Range.

### 7.3.2.5. Service List management

#### *7.3.2.5.1 First initialisation*

When a receiver is first initialised or reinitialised (e.g. because the user applied for a factory reset), it is expected that user will be present in front of the receiver.

The receiver shall perform in accordance with the following rules:

a) It should give the user the possibility to choose between automatic (LCN-driven) and manual (based on discovery) service numbering (see above).

b) If automatic service numbering has been selected the receiver shall attempt to allocate in the Service List each service with associated LCN(s) to the service number(s) equal to the LCN(s) requested for that service. This rule implies that if there is only one service with a particular logical_channel_number request, it shall be allocated to that service number.

c) In the case of the presence of the same service (identical DVB triplet - ON_id, TS_id & S_id) on two different frequencies, the conflict shall be resolved as described in §7.5.5.2.
d) In presence of a conflict between different services that request the same logical channel number the receiver shall first check if the conflict would arise between a service from a network from the country selected at first installation time, i.e. from a network whose network_id comes from the range assigned to that country by DVB *or for one of the countries associated in the OSDT to that service*, and a service from another country. In that case the requested service number will be allocated to the former and the latter will be moved in the Main Overflow.
Otherwise the receiver shall:
- present the viewer with a menu allowing to select which channel to maintain at the requested position; automatic resolution of the conflict, either based on signal power or first/last found during scan, will be performed after expiration of a suitably long timeout
- allocate the other service(s) to the next unallocated number(s) in the Main Overflow.
e) If a service does not have an associated logical_channel_number, it shall be allocated an available number in the Main Overflow.

The detailed expected behavior for cross-border LCN conflicts resolution is the following:

- if a particular LCN position is claimed by only 1 service, it will be granted that position regardless of its network_id (NID) *or OSDT's CountryCodes* and of the position claimed (i.e. including LCNs in Main Overflow range)
- if more services are competing for the same LCN position
    - if only 1 service has its NID within the range 0x3001 - 0x3100 *or CountryCodes="ITA" in OSDT* (if Italy has been selected as Country at installation time,) it will automatically get the requested position
    - if more services have their NIDs within the range 0x3001 - 0x3100 *or CountryCodes="ITA" in OSDT*, the conflict resolution amongst such services is left up to the customer. Possible competing services whose NIDs is outside the range 0x3001 - 0x3100 *or having CountryCodes ≠ " ITA " in OSDT* will be automatically moved to Main Overflow range (850-999)
    - if all competing services have their NIDs outside the range 0x3001 - 0x3100 *or having CountryCodes ≠ " ITA " in OSDT*, the conflict resolution is left up to the customer
    - whatever the above case, all the other services which haven't got the requested position will be moved to Main Overflow range (850-999)

#### *7.3.2.5.2 Adding new services*

When adding services to the Service List as a result of an update scan (whether manual or automatically, in stand-by or in operate mode), the receiver shall first try to allocate each new service to the number(s) indicated in the LC descriptor, if any. That applies also to each service which is already in the Service List but at a position different than the LCN itself. Should such position be actually free, the receiver will move the subject service there in the Service List, to cope with services which didn't have an LCN at the time when they were first tuned.

In case of conflict (i.e. the number is already occupied by a "non-invisible" service or is requested by several services), the receiver shall proceed with the same rules given above for first initialisation (§7.3.2.5.1).

In particular, after signalling to the user that new services are available (as in the procedure described in 7.6.5), the receiver SHALL display a pop-up menu for each case of conflict, to allow the viewer to select which service to allocate to the requested service number. If there

is already a service at the requested number, that service SHALL be the first in the list and the one selected by default (e.g. in case of timeout). If the update scan is performed while in stand-by, pop-up menus for conflict resolution SHALL be displayed immediately after leaving stand-by mode.

#### *7.3.2.5.3 Removing a service*

If, during an automatic or a manual update scan, the receiver decides that a service can be removed from the Service List, it will exclude the service and its service number from the Service List and the Master User List.

A service will be considered as removed in case it's no longer present in the NIT actual and the SDT actual or in OSDT.

### 7.3.2.6. Master User List Management

#### *7.3.2.6.1 Creating the Master User List*

Once the Service List is created or rebuilt, the Master User List shall be created/rebuilt, equal to the Service List.

#### *7.3.2.6.2 Modifying the Master User List*

The user is free to modify the names in the Master User List, to delete services, and to move services from one number to any another.
If the requested number was unoccupied it will be attributed to the service being moved (the original service number becoming available).
It the requested number is occupied, there shall be a switch of service numbers (whether determined by LCN requests, manually or automatically) between the services.

#### *7.3.2.6.3 Updating the Master User List*

When new services are added to the Service List, they shall also be added to the Master User List, with the same service number as in the Service List, but with the following complementary rules:

- If a service number (as it appears in the Service List) is occupied in Master User List by a user modified service, the service shall be allocated the next available number in the Main
- User deleted services shall be reintroduced in the Master User List only when there has been a modification in the Service List due to the service being available on a new frequency.

#### *7.3.2.6.4 Renewing the Master User List*

It is strongly recommend that the user shall have the possibility, at any time, to re-create the Master User List by importing the Service List.

### 7.3.2.7. User Favourite List(s)

Those lists are created and modified at the request of the user. They are not automatically modified by the update of the Service List or of the Master User List.

### 7.3.2.8. The Preferences Zone

In the Preferences Zone (service numbers 1-99), all services numbers (already occupied by a service or "empty") are available for placing a preferred channel, by the user.

When a service carrying a LC descriptor, requests an already occupied service number, the user shall be able to select which service to allocate to the requested number; the other service shall be assigned the first available position in the Main Overflow.

#### 7.3.2.9. The Assignment Zone

In the assignment zone, only occupied numbers need to be available to the user to modify the numbering scheme (pre-assigned or done by the receiver).

The receiver SHALL manage a Main Overflow range, at the high end of the available numbers.

> **Overflow Range ("Garbage collector")**: the service numbers in this range are assigned to services whose type cannot be identified or is patently erroneous, and to services which cannot find an available number in their category's range.

In the absence of a LC descriptor, a receiver shall not try to allocate automatically services to another zone than the Overflow Range, where the services need not be sorted by service type.

In case the receiver implements separate lists for TV and radio services, a Main Overflow (with the same numbering range) should be included for each service type.

In case of conflict in the Assignment Zone (a LCN carrying signal requesting an already used number), the user shall be given the possibility to choose which signal to allocate to the specified service number. The other service shall be redirected to the Main Overflow.

### *7.3.3. Service variation options*

#### 7.3.3.1. Service regionalisation

When a service dynamically become regional (e.g. for regional news) it is recommended that the regional transmissions at all times be identified as separate services (different DVB triplets). In this case the service may have the same LCN descriptor: this allows the user in zones common to two or more regionalized services to select which one to allocate to the requested service number.

#### 7.3.3.2. Network re-configuration

For major network reconfigurations, it is recommended that the user proceed with a re-installation, even at the risk of losing his/her custom numbering, if any.

When the receiver detects a service offer change, which includes the addition and deletion of multiple services and/or networks it shall first remove all services which it can determine positively (see Removing a service) to be removed permanently from the service list, and then add the new services.

#### 7.3.3.3. Change of LCN numbering scheme

Any re-arrangement by the broadcasters of LCN numbering of services will be treated as above under network re-configuration. This implies that user changes and non-default allocation of services to service numbers by the receiver should be preserved as much as possible unless a re-installation is done.

## 7.4. Receiver functions

### *7.4.1. Service Change*

When changing service, parameters need to be set to deal with video formats, languages and unexpected failures in service selection. The minimum requirements for receiver behaviour during service change are outlined in the following paragraphs.

#### 7.4.1.1. Audio language

It is assumed that the user has entered one or more language preferences during the receiver installation process. If the selected service has audio tracks in more than one language, the language is selected according to the user preferences.

- If preferred languages do not match any of the available languages, then the receiver shall automatically select the "undefined" ("und" code of the ISO_639_Language_descriptor) audio stream.
- If "undefined" stream is absent, the stream with the lowest PID (lowest numerical value - unsigned integer) in the specified program shall be selected.
- In case no language descriptor is specified the audio stream with the lowest PID shall be selected.

In addition to this automatic soundtrack selection, it shall always possible for the user to manually select any of the available languages.

#### 7.4.1.2. CA controlled services

Where a component cannot be presented due to the presence of scrambling, an error message shall be displayed. Otherwise the receiver shall present the component, even in the presence of a CA descriptor.

### *7.4.2. Service Not Available*

If the video component within a video service, the audio component in a radio service or the data component in a data service can not be presented because it is no longer accessible on the registered parameters (PID, etc), an error message is shown to the user indicating that the service can not currently be accessed. In case secondary components are missing, the receiver shall present the main component of the service: e.g. a video service with no audio component shall be presented anyway with no error message.

"Service not available" error message SHALL NOT be shown if an HbbTV auto-start application is associated to the service.

The receiver SHALL present all the components of a service it can present.

## 7.5. Service list initialization and maintenance

A general principle is that any scanning[15] procedure shall make accessible to the user all the services available at a given location.

New multiplexes or new channels inside already existing multiplexes or new linear IP services will be started over the time both nationally and locally.

It is important to make it very easy for the user to enjoy all the new channels and services as soon as they are active, without any need for a manual rescan. This will be the best and most effective way to inform the viewer that new channels and services are available. This will improve the viewer experience and, as a consequence, help the Hybrid DTT platform to succeed.

The receivers should be able to automatically and regularly update the channel and service list without the need of direct intervention by the viewer. This will make much easier for the final user to install the receiver and to keep the receiver updated with all the new channels and services that can be received in his coverage area.

[15] Here and in the following the term "scan", strictly applicable to broadcast, is used also for linear IP services

Obviously, the viewer has to be able to perform a complete scan at any moment, either manually or automatically. Furthermore, the viewer SHOULD have the possibility to disable the automatic channel and service list update procedure.

### 7.5.1. General Requirements

In order to make receivers capable of managing the situations previously described, the following functions SHALL be implemented:

- **manual full scan**: the procedure, initiated by the user, performs a full (automatic) scan of the spectrum and processes OSDT(s) (if any); it can be used to **update** the channel and service lists or to **re-install** everything from scratch;
- **manual scan (single channel)**: a manual tuning procedure allowing the user to manually select and tune a single VHF/UHF channel (giving for example the channel number) or the OSDT(s) (if any)
- **automatic full scan**: the procedure is initiated automatically by the receiver; it performs a full (automatic) scan of the spectrum and processes again OSDT(s) (if any) with the only purpose being to update the lists;

**T2-IRDs SHALL provide a single list containing both DVB-T and DVT-2 services, plus linear IP services (if any).**

For the terrestrial part of all the described tuning procedures, receivers SHALL scan the following spectrum bands [2]:

- III-VHF (BW=7MHz with European channel raster),
- IV-UHF and V-UHF (BW=8 MHz).

### 7.5.2. First Installation Procedure

- At first installation the receiver SHALL perform an automatic scan over the entire spectrum bands and process OSDT(s) (if any), as defined in §7.5.1, searching for all the digital services available.
- At the end of the scan, all the channels and services found (audio/video/data) are stored in the channel and service list
- If automatic ordering of channels and services mechanism is active (based on a logical channel numbering scheme) the resulting lists will be organised according to the criteria described in section 7.3.4.5. Otherwise the list will be organised according to frequency scan order.
- The receiver SHALL provide an interface allowing the user to access the list and move, rename, discard or restore services from the list.
- When the user discards a service from the list, the service is no longer visualized in the list. It is just stored in the “discarded service list” from which it can be retrieved in any moment by using the “service restore” function.
- When either the manual or automatic scan procedure is started for updating the service list, those services that are included in the discarded services list SHALL not be re-introduced in the main channel list. In case the service list is reinstalled, both the main service list and the discarded service list SHALL be re-initialized.

### 7.5.3. Manual Full Scan Procedure

#### 7.5.3.1. Update

The receiver SHALL:

- update (where necessary) in the list those services which were already existing; for example:

  - the receiver shall detect a service name ("service_name" is SDT, "ServiceName" in OSDT) change of a given service and update it unless it was manually edited by the end user;
  - if automatic ordering is active, the receiver shall move, if possible based on the rules given in §7.3.2.5 for allocation and conflict resolution, an existing service to the new position indicated by the LCN;
- insert newly available channels or services (audio/video/data) in the relevant list:
  - if they carry an LCN and automatic ordering is active, the rules given in §7.3.2.5 for allocation and conflict resolution apply;
  - if they don't carry any LCN or if automatic ordering is not active, they will be appended at the end of the list.

#### 7.5.3.2. Re-install

Same as §7.5.2.

### *7.5.4. Manual Scan Procedure (Single Channel)*

Same as §7.5.3.1 on single channel.

### *7.5.5. Automatic full scan (Automatic service list update)*

To maintain an up to date service list, the receivers SHALL implement an automatic service list update procedure, in accordance with the following requirements:

- The receiver SHALL perform an automatic scan at regular intervals (at a specified hour and with a specified frequency) to search for new services.
- The automatic scan can be performed both in standby mode (recommended) and in operate mode (optional). Refer to the following table for automatic channel scan default settings.
- The automatic scan in either mode can be disabled – separately - by the user, but, as a default setting, it should be active only in stand-by mode. In case user would decide to disable automatic search for new channels in standby mode he/she should be warned that this way the capability of automatically tracking evolution of networks and services will be hindered. For this purpose a message like "Warning! After disabling this feature the receiver won't be anymore able to keep your channel list automatically updated with respect to services on-air" (Italian translation: "Attenzione! Disabilitando questa funzione il ricevitore non sarà più in grado di aggiornare automaticamente la lista canali in base a quelli effettivamente trasmessi") should be presented.
- When the receiver performs the scan, looking for new channels, it compares any single service found with the list of services already registered. This comparison will be based on frequency, Ts_id, On_id and Service_id of the broadcast services and on OSDT's DVBTriplet of linear IP services. The comparison SHALL take into account all services including those that were discarded by the user from the channel/service list and are listed in the "discarded channel list".
- For those services already registered in the service list, the receiver SHALL:
  - detect a "service_name" change and update it unless it was manually edited by the end user;
  - if automatic ordering is active, move an existing service, if possible based on the rules given in §7.3.2.5 for LCN allocation and conflict resolution, to the new position indicated by the LCN;
- If any service is found with frequency, Ts_id, On_id or Service_id or with OSDT's DVBTriplet different from those of the channels already registered, it will be added to the channel list (in its own category group) according to the following rules:
  - if new service carries an LCN and automatic ordering is active, the rules given in §7.3.2.5 for allocation and conflict resolution apply

  - if new service doesn't carry any LCN or if automatic ordering is not active, it will be appended at the end of the list.
- If any new service is found a message will be shown on screen when the receiver is switched on (if it was in standby mode) and will be left on screen until the user presses the OK key. The message will be something like: "New channels were found and added to the channel list" (Italian Translation: "Sono stati trovati nuovi canali in onda. I nuovi canali sono stati aggiunti alla lista canali").
- In case both the "search for new channels in standby mode" and the "search for new channels in operate mode" options are set on "YES", than the receiver must start the automatic scan at the time indicated for performing the channel search in operate mode.
- In case the "search for new channels in operate mode" is available and set on "YES", at the time specified for starting the procedure, a 30 seconds countdown will appear on screen with a message like the following: "The receiver will start looking for new channels in … seconds". Italian translation: "Il Box Interattivo comincerà la ricerca di nuovi canali entro … secondi" (mutatis mutandis for IDTV sets). The user will be able to press "OK" for letting the procedure start immediately or "exit" for aborting the procedure. In case the user will choose "exit", the procedure will be aborted and will not be performed again until the next scheduled time.
- In case the "search for new channels in standby mode" option is set on "YES", but the "search for new channels in operate mode" option is available and set on "NO" (or was aborted – refer to previous point), the receiver shall start the scanning procedure some time, implementation dependent, after being put in standby mode (in case the receiver is put in standby mode more than once a day, this procedure has to be performed only once daily).

#### 7.5.5.1. Default settings for automatic scan

| N. | Settings / Italian Translation | Default settings |
|---|---|---|
| 1 | "Automatic search for new channels in standby mode" / "Ricerca automatica di nuovi canali in standby" | YES / SI' (MANDATORY) |
| 2 | "Automatic search for new channels in operate mode" / "Ricerca automatica di nuovi canali a decoder acceso" | NO / NO (if available) |
| 3 | "Time" / "Ora" | 04:30 AM |
| 4 | "Repetition" / "Frequenza" | "Daily" / "Quotidiana" = default ("Weekly" / "Settimanale" – other options possible) |

Table 31: Default settings for automatic scan

#### 7.5.5.2. Handling of duplicate services

In presence of the same service available on different frequencies/Transport Streams, the Receiver shall behave as follows.

When identical services (i.e. with the same original_network_id, transport_stream_id and service_id triplet) are received on different frequencies (obtained from different transmitters or generated by the MATV system), the receiver should present to the user all of the instances of the service (i.e. including duplicates). In the channel list, the position associated with the lowest ordinal number should be given to the service with the best QoS. Extra instances of services should be regrouped at the end of the list.

The minimum requirement is that only the instance with best C/N out of the services with the same DVB triplet found during scan shall be kept, provided that the situation is revisited at each automatic or manual rescan.

In the context of interactive applications (e.g. an EPG) the (unique) DVB Locator of duplicate services shall refer to the one with the best QoS. (In case of equivalent QoS, it shall refer to the service first discovered).

#### 7.5.5.3. Automatic Ordering of Channels and Services in absence of LC descriptor acquisition

If the off-the-air LC descriptor acquisition mechanism is not activated in the receiver, the services shall appear in the order they have been detected (taking into account the procedure described in 7.6.2) and grouped into three categories in the following order:

- TV channels
- Radio channels

Interactive services linked to TV or Radio services shall not be shown.

### *7.5.6. Network evolution*

As specified in Table 33 on default settings for automatic scan, the receiver SHALL implement, by default, an automatic scanning procedure, to adapt the receiver to the evolution of the network.

As specified in §6.1.1.1, changes in modulation parameters of existing services SHALL be automatically detected.

### *7.5.7. Default channel numbering of services*

No default service numbering shall be implemented by manufacturers.

## 7.6. User interface to the SI carried data

This clause describes the minimum set of views of the SI information that receivers shall (M), should (R) or may (O) be able to present to the user.

The minimum lengths for text fields (if present) that shall be displayed by receivers are defined in the following table. Note that the figures given are for the number of displayable characters (including spaces) required to represent the text field. The number of bytes required will depend on the use of control codes and whether one or two byte character representation is used.

| Field name | Field length in displayable characters | M/R/O | Comments and examples |
|---|---|---|---|
| Network Name | 24 | O | “Operator X” |
| Service Provider Name | 20 | O | “Media Company Y” |
| Service Name<br>or Preferred Name | 32 | M | “Italia International”<br>Full name for display on set-up menus |
| Short Name of Service | 8 | O | “It.Int”<br>A short version for display on browse and listing display. Possibly shortened by broadcasters from full name by use of escape characters as defined in TR 101 211. Otherwise the full length Service Name should be displayed. |

| Field name | Field length in displayable characters | M/R/O | Comments and examples |
|---|---|---|---|
| Event Name | 40 | M | “La Grande Zia”<br>Individual broadcasters are free to add an episode title to the title within the space, for example “Lo Zio: la Storia Segreta” |
| Short Event description | 200 | M | “Un giorno, Zio esce per cercare sigarette. Torna venti anni dopo.” Broadcasters must ensure that the text does not overflow the maximum descriptor size. |
| Extended Event Text | 3984 | O | The extended event text complements the short event description. |
| Component description | 32 | O | “In alta definizione” |

Table 32: Text Field Lengths

### *7.6.1. Timer*

Must be locked to the Time & Date Table (TDT) and adjusted by the Time Offset Table (TOT), if broadcast.

### *7.6.2. Access to the Service list*

Access to the Service List shall be provided through a dedicated key (recommended) or by a resident menu. This list shall present TV Channels, Radio Channels, and Independent Interactive services (i.e. when they are not bound to a TV or a Radio service, or another Interactive Service) following the indication of the associated LC descriptor.

If the LCN acquisition mechanism is not active, the Service List shall be grouped by:

- TV services,
- Radio services

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# 8. Content protection

## 8.1. Smart Card based systems

Pay TV services or other services with controlled/conditional access are an integral part of the Italian DTT platform.

It is not expected that all network operators/broadcasters present in Italy will agree on a single system. It is even disputable, for anti-piracy and management reasons, that a single system should indeed be used.

Based on both CA providers and manufacturers willingness, the CA system(s) adopted by one or more specific operator(s) could be either embedded in the receiver or implemented in a Conditional Access Module (CAM) plugged in a Common Interface (CI) slot.

In this latter case, if a CICAM is provided with the digital receiver (e.g. in case of iDTV), the CICAM provider and the digital receiver provider guarantee the coexistence of more CA systems in the same manner as embedded CA system(s). The CICAM provider and the iDTV vendor guarantee the same security level as for CAS embedded.

### *8.1.1. Embedded CA(s)*

Devices providing smart card interface for embedded conditional access purpose shall be conforming to the ISO 7816 standard, levels 1 to 3 (with T=0 and T=1).

Embedded CAS integration is based on proprietary implementations which require agreement between Device Manufacturer and Embedded-CAS provider. It is then out of the scope of this document.

### *8.1.2. CICAM*

Receivers complying with this document SHALL be consistent with the CI Plus Limited Liability Partnership (LLP) specification [37].

#### 8.1.2.1. CICAM Player mode

*Terminal SHALL support Host initiated play of content using CICAM Player Mode, both for VOD and Live contents, as well as for IP linear services, as specified in CI Plus LLP Specification [37]. Support for CICAM initiated playback is OPTIONAL.*

#### 8.1.2.2. CICAM with IP connection

*Terminal SHALL support CICAM Player Mode where the CICAM performs direct IP data retrieval without the use of the LSC resource. The Terminal SHALL determine that the CICAM performs direct IP data retrieval when the CICAM starts the 'CICAM player session' with input_max_bitrate set to zero.*

#### 8.1.2.3. CICAM using Host connectivity

*Terminal shall support CICAM Player Mode where the CICAM performs IP data retrieval by requiring the setup of a Hybrid LSC connection.*

#### 8.1.2.4. Virtual Channel and Auxiliary File System

Terminal SHALL provide a mechanism which allows the user to launch an interactive application provided by the CICAM, whenever he/she selects a channel which is also provided by the CICAM. Such a channel SHALL be listed in the channel list provided by the terminal.

The mechanism is based upon features provided by CI Plus LLP Specification [37], i.e.:

- Virtual Channel
- Auxiliary File System
- Application MMI

The mechanism to coordinate virtual channel access with CICAM interactive application launch is fully provided by CI Plus LLP Specification [37] clause 5.4.

#### 8.1.2.5. Low Speed Communication resource V4

In order to allow a CICAM to perform a speed test of the terminal's broadband connection, the terminal SHALL implement LSC version 4 as described in CI Plus Specification [37], including the Hybrid LSC Connection.

#### 8.1.2.6. Physical engagement

The Common Interface Connector and the Module SHOULD be implemented in such a way that the smart card shall be inserted with the contact area facing upwards when horizontal.

#### 8.1.2.7. Backward compatibility

Host SHALL provide full backward compatibility to previous version of CIPlus (earlier than [37]) and to DVB-CI [15].

In particular, a Host SHALL operate according to the version agreed between CICAM and Host.

#### 8.1.2.8. Implementation guidelines

In order to enforce the above requirement on backward compatibility, some recommendations regarding particular scenarios where issues were found are given in the following. Refer to [40] Annex E too, for clarifications about CICAM use cases.

##### *8.1.2.8.1 General*

1. Should the CA(s) associated to the tuned service be supported both at Host (embedded) and Module level, the former SHALL have the priority as active (descrambling) device.
2. By default, during the channel scanning procedure all the channels found SHALL be stored by the device independently from the channel scrambling status.
3. The Host SHALL maintain the last tuned frequency when entering the main menu;
4. To cope with possible Module malfunctioning without requiring extreme measures by customers, like Module extraction/insertion and/or Host power unplug/plug cycles, the Module SHALL be restarted as soon as Host comes out of stand-by (Module power-cycle or Module reset). The exception to this is if the Module is performing some task that requires it to remain operational (e.g. Host is recording and requires the CICAM to continue to descramble).
5. Host first installation while Module is inserted, could lead to two different failure scenarios:
   a. Module authentication failure during channel scan, in relation to:
      i. Lack of signal
      ii. Muxes carrying bad data in DVB-SI table used to get time-date (TDT and TOT)

      In order to avoid these scenarios, Host SHALL send to the Module a RESET command as soon as the first installation is terminated.

b. Host first installation failure. In order to avoid this scenario, Host SHALL ignore any MMI message coming from the Module during first installation process.

6. Host SHALL ignore any Module request, through the Host Control resource, of tuning to a service with dvb://0.x.y locator;
7. Whenever communication between the Host and the Module has been lost, i.e. polling function time out expires (see [15] A.4.1.12), Host SHALL reset the Module, in order to properly restart it

#### *8.1.2.8.2 High Level MMI*

1. Host SHALL support the High Level MMI Interface as specified in [37]
2. Host SHALL include in the main menu a CAM defined Menu tree.
3. Host SHALL support MMI Pop-ups.
4. Host SHALL comply with the following requirements applied to MMI pop-ups and CAM menus:
   - at least 5 lines SHALL be displayed simultaneously
   - in case of pop-ups/menus composed by more than 5 lines the display SHALL support scrolling.
   - at least 50 characters SHALL be displayed for each line
5. Host SHALL allow MMI pop-ups to have control of the Remote Control keys until the user exits the MMI itself. MMI messages shall not be automatically closed.
6. Host SHALL allow MMI to support the following RC keys:
   - Numeric keys
   - UP, DOWN, LEFT, RIGHT arrow keys
   - OK key
   - Back/Exit key(s)
7. In case a System RC Key (P+, P-, Menu, List, …) is selected by the customer while a pop-up message is displayed, Host SHALL close the popup and perform the related system action.
8. Host SHALL allow MMI pop-ups to have higher video priority over downloaded HbbTV applications.

## 8.2. Embedded DRM based systems

### *8.2.1. Introduction*

*As for embedded CAS, adoption of one or more DRM systems is outside of the scope of this document and it is left up to interested Operators and device Manufacturers instead.*

### *8.2.2. Common Encryption (CENC)*

*In addition to the media formats defined in Table 3, the Common Encryption for ISO Base Media File Format (CENC) [59] SHALL be supported by DRM-enabled receivers. CENC is used to protect contents packaged in MP4 container and delivered either with HTTP Streaming or HTTP Adaptive Streaming.*

*The CENC protection scheme enables DRM interoperability at the content level for IP delivery much like Simulcrypt does for CA systems in the broadcast environment.*

*Common Encryption for MPEG-2 TS protected contents is left for further study.*

## 8.3. Protection of IP linear services

*When an IP linear service is selected, the terminal shall use the corresponding ServiceLocation available from the OSDT in order to determine whether the CICAM Player shall be used for the service decryption.*

*When DRMControlInformation element is absent from at least one of the ServiceLocation of the IP linear service, then the terminal shall consider the IP linear service as non-encrypted and shall proceed on its own for service presentation, without requiring usage of the CICAM Player.*

*When DRMControlInformation element is present in all the ServiceLocation of the IP linear service, then the terminal shall consider the IP linear service as encrypted, and shall evaluate each ServiceLocation in turn, in descending priority order, until the terminal determines that a ServiceLocation is supported by an embedded DRM or by the CICAM Player of one of the present CICAM(s).*

*During evaluation of a ServiceLocation, the terminal shall first verify whether it is supported by an embedded DRM. When a ServiceLocation is not supported by an embedded DRM, then the terminal shall secondly verify whether it is supported by one of the present CICAM implementing the CICAM Player mode.*

*When the terminal determines that a ServiceLocation is supported either by an embedded DRM or by a CICAM, then the terminal does not evaluate the other ServiceLocation with lower priorities, if any, and shall select the matching configuration, either embedded DRM or CICAM Player, to decrypt the IP linear service.*

*In case the IP linear service is effectively encrypted and the terminal has no possibility to decrypt the service neither by use of an embedded DRM, nor by use of a CICAM, nor by use of any other unspecified mean, then the terminal shall present an error message.*

*The above behavior is represented in the following informative flow chart:*

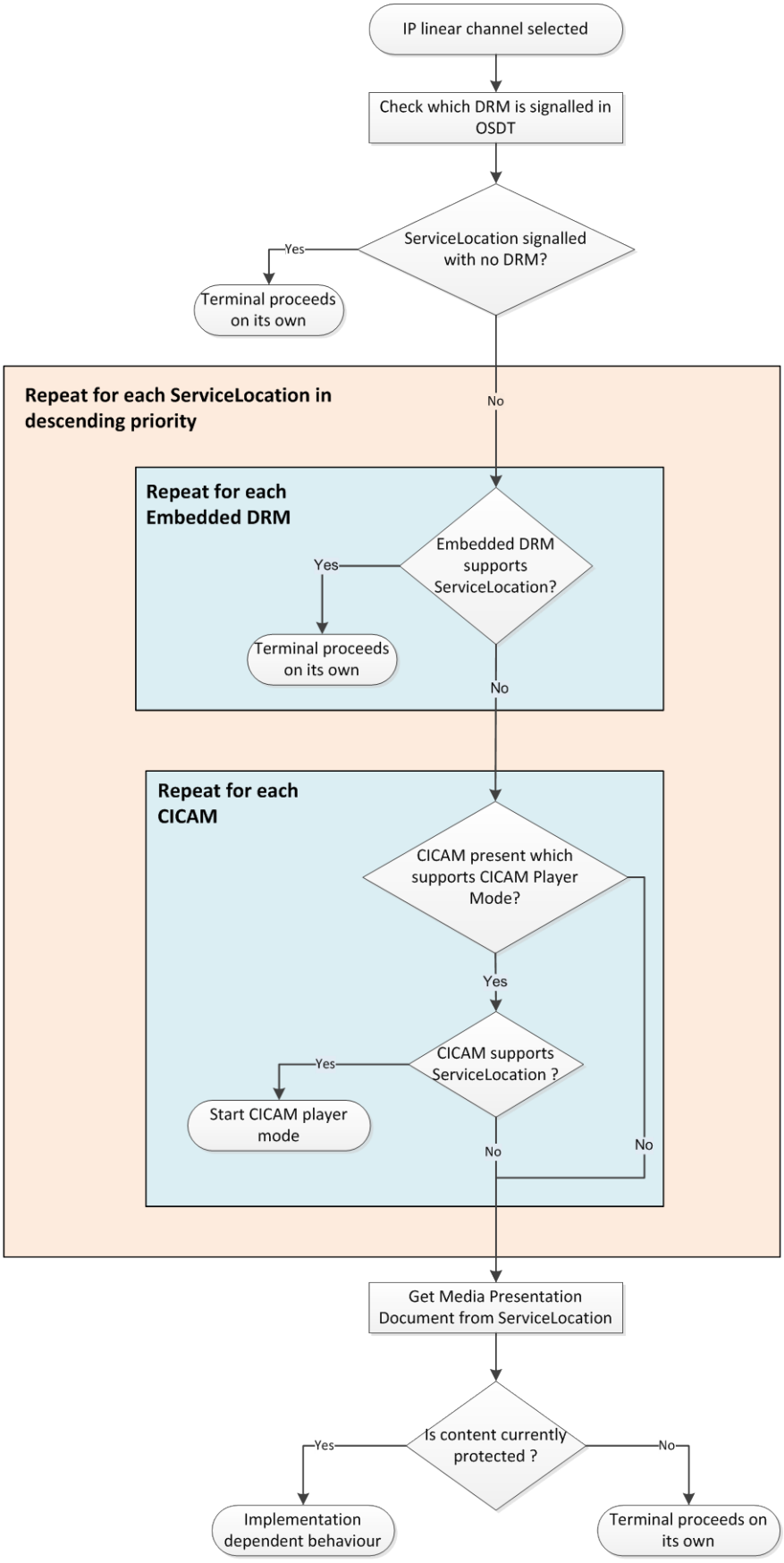


Figure 6: Linear IP channel DRM selection

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# 9. Resident Software and API

Enhanced and interactive television services are an essential part of the Digital TV proposition. Receivers must fully support all specified functionality.

## 9.1. Services

### *9.1.1. Teletext*

Teletext [12] is an important medium in Italy. Not all analogue Teletext services will immediately be converted to interactive applications. Thus there is a need to maintain compatibility with DVB Teletext [11].

The DVB Teletext signal shall be decoded and presented within the receiver and displayed using graphical functions (so-called Teletext Mode 2). That's particularly true for STBs as (analogue) VBI Teletext signal cannot be carried across (digital) HDMI interface. At least level 1.5 Teletext, as defined in ETS 300 706 [12], shall be supported.

One single remote control is then sufficient to view audiovisual services and Teletext using the "Text" key.

In order to preserve customers' investments in TV sets with advanced Teletext features, Teletext signal shall be anyway reinserted on the TV SCART and RCA (if present) VBI lines. Insertion shall conform to ITU-R BT.653-2 [31]. Teletext data will be inserted from lines 6 to 22 and 320 to 335.

It is recommended that VBI data, including Teletext, be reinserted on the VCR SCART (including the Y/C signals) when present (see 6.1.4.2), even if many VCRs will not be able to replay this data. Insertion shall conform to ITU-R BT.653-2 [31]. Teletext data will be inserted from lines 6 to 22 and 320 to 335.

### *9.1.2. Subtitling*

Concerning subtitling it is expected that broadcasters will follow the EBU recommendation on subtitling in digital services [7]. However, compatibility must also be maintained with subtitling through Teletext.

As a consequence, the receiver SHALL implement DVB Subtitling and Teletext subtitling.

#### 9.1.2.1. DVB Subtitling

DVB Subtitling shall be implemented in conformance with [18].

*HD Subtitling shall be implemented according to [28].*

*A Display Definition Segment shall only be included in the subtitle stream when the video is HD. The maximum display_width shall be 1919 and the maximum display_height shall be 1079. It is recommended that receivers support Display Definition Segments.*

#### 9.1.2.2. Teletext Subtitling

Teletext subtitling is part of both Teletext modes described above. Information about the presence of Teletext subtitles shall be obtained from the teletext descriptor and this information shall be made available to the user, at his request (e.g. when pressing the "Sub" key, or through a banner).

It is acceptable to make the user select the relevant teletext page for viewing subtitles, as long as a clear message on the availability and modality of access to the subtitles is presented to the user (e.g. a channel banner).

Where possible, receivers should be able to display both subtitles and interactive graphics simultaneously. However, not all receivers may be able to do this: in that case, when an application is activated, it shall be able to suspend the rendering of Teletext.

## 9.2. Resident Software

### *9.2.1. Resident Manufacturer Specific Applications*

#### 9.2.1.1. Navigator

It shall be present. It is defined by the manufacturer (see [1]).

##### *9.2.1.1.1 Handling of input events by the Navigator*

When the receiver is in TV Viewing Mode (see definition §4.1), it is expected that any running application shall release input keys VK_0 to VK_9. The Navigator shall always be able to handle those input events.

The Navigator must also handle all the other keys used for TV viewing (e.g. channel list, volume, and channel up/down). Those keys are different from the keys of the “Interactive Pad” (see §6.2 on the Remote Control, in the D Book [36]).

### *9.2.2. Parental Control*

The receiver shall provide a PIN-controlled Parental Control menu to perform the following functions:

1) setting age thresholds (at least for 14 and 18 years) for viewing single events
2) changing the PIN value
3) activating/deactivating PIN checking on 1), 2), 3) above and on the menu itself

The PIN value SHALL be explicitly set by the user during installation procedure. In conformance with National Authority AGCOM Directive 220/11/CSP [66], manufacturers SHALL NOT provide a default value for such a PIN. Reset of the PIN, e.g. in case it was forgotten, can only be achieved through an overall receiver reset to the out-of-the-box status. User SHOULD be duly warned about this drawback during installation procedure.

From the receiver Parental Control menu it shall be possible setting an age threshold to be matched against the value set by broadcasters, on a per event/content basis, in:

- the Parental_rating_descriptor of the EIT (conventional DVB services)
- *the ParentalRating of a DVB-DASH MPD, as specified in §7.2.2.2 (linear IP services or CoD contents)*
- *the <ParentalRating> element of a CAD (CoD contents)*

If this value is equal or greater than the age threshold set, the current event can be viewed only entering a PIN. Such PIN is the same as the receiver’s Parental Control PIN (if any). The PIN protection can be enabled/disabled by means of an appropriate receiver menu. At least the 14 and 18 years thresholds must be present.

The parental rating is associated to one or more countries through

- the country_code in EIT’s Parental_rating_descriptor

- *the CountryCodes in OSDT's TargetRegions*
- *the Region attribute in CAD's ParentalRating element.*

That could either be a code assigned to a single country (e.g. "ITA" for Italy) or to an ETSI defined group of countries (e.g. "902" for all countries, "905" for Europe). A given parental rating will be applicable if the associated country code would match or include the country set in the receiver at installation time.

By default the receiver shall be set to block all events and/or channels flagged with an 18 years threshold.

Locking/unlocking single services could be also optionally offered by manufacturers. In this case from the Parental Control menu it will be possible to lock one or more specific services so that they can be viewed only entering a PIN. Such PIN is the same as the receiver's Parental Control PIN (if any). The PIN protection can be enabled/disabled by means of an appropriate receiver menu.

## 9.3. Hybrid broadcast broadband TV (HbbTV®)

*The receiver SHALL access all Italian broadcast digital terrestrial television, radio and interactive services, based on HbbTV standard [6]. Receivers SHALL implement all errata published against this specification, to take advantage of bug corrections.*

### *9.3.1. Content protection aspects*

#### 9.3.1.1. Embedded DRM

*If a terminal provides one or more DRMs for use by an HbbTV application, it SHALL support the DRM feature and expose those DRMs as defined by HbbTV specification [6].*

#### 9.3.1.2. CICAM

##### *9.3.1.2.1 Broadband contents managed by the CICAM*

*Terminals compliant with section 8.1.2 SHALL support CICAM player mode including trick mode operations (mapping between HTML5 video element and CICAM player mode), as defined in section 11.4.5 and Annex K of HbbTV specification [6].*

##### *9.3.1.2.2 CICAM - Virtual Channel and Auxiliary File System*

*Terminals compliant with section 8.1.2 SHALL support virtual channel mechanism in order to start an HbbTV application provided by the CICAM Auxiliary File System, as defined in section 11.4.4 of HbbTV specification [6].*

### *9.3.2. Service requirements*

*In relation to [22] and [25], the following features SHALL be provided.*

#### 9.3.2.1. Launching a CS application from an HbbTV® application

*It is required that "terminal manufacturer (or one of their agents) provides a Companion Screen application that can link to, and control the terminal from the Companion Screen application", as defined in HbbTV specification [6], in relation to "Launcher application".*

#### 9.3.2.2. Interaction between Resident and Downloaded Application

When a resident application is called by the user or automatically, it should not kill the running HbbTV application.

In case the application is being loaded when the resident application is called, the application should continue being loaded in the background.

### *9.3.3. Coexistence with legacy MHP applications and receivers*

*Terminals compliant with this specification SHALL ignore, as expected, the reserved_future_use bit preceding the application_type field in the application_signalling_descriptor. According to TS 102 809 [34] all reserved_future_use bits in interactive application signalling should be set to "1" but lab tests with signals reproducing the future simulcasting of MHP and HbbTV applications on the same service have shown that most legacy MHP receivers wouldn't work properly in such scenario if that particular bit was set to "1" in the application_signalling_descriptor of HbbTV application. As a consequence this reserved_future_use bit within the PMT will be set to "0" by operators simulcasting MHP and HbbTV applications on the same service.*

## 9.4. Maintenance and Upgrade

It is very important for the receiver to be able of automatically and regularly look for available software upgrades and to automatically load and install such new software.

The procedure must be designed to guarantee both the manufacturers and the broadcasters that over-the-air software upgrades are received and automatically installed on the receiver in the households. This will also make the viewers sure that their receivers are always updated and fully compliant with the applications on air.

The process of upgrading shall cause minimal disruption to the viewer. However, to minimise the diversity of deployed software builds and to most efficiently use the available broadcast capacity, the receiver must detect and act upon the broadcast of the relevant software download. After a System Software Update has been performed, user settings like services listings (preferred, etc,) shall be preserved, whenever feasible.

Obviously, the viewer has also to be able to perform a manual search for software upgrades in any moment. Further, the viewer has to be allowed to disable the automatic software upgrade procedure.

### *9.4.1. Automatic software upgrade procedure*

To allow for a simple user interaction, the receiver SHALL behave in the following manner:

1. The receiver has to automatically look for available software upgrades over the air.
2. The automatic software upgrade procedure can be disabled by the user.
3. When the receiver looks for available software upgrades, it has to scan all the multiplexes.
4. The software upgrades put over the air need to be model specific so that there is no chance that a software intended for a particular receiver model can be downloaded and installed on a receiver with a model different from that to which the software upgrade was intended, as specified in DVB TS 102 006 [23].
5. If any new software version is found, it will be automatically downloaded, but should only be installed after explicit confirmation by the user (manufacturer option).
6. The automatic software upgrade can be performed both in standby mode (mandatory) and optionally in operate mode (at a specified hour and with a specified frequency). Receivers are not required to perform automatic software upgrade while in low power mode. Refer to the following table for automatic channel scan default settings.
    a) If the "automatic software update in standby mode" option is set to "YES"

- in supposedly stable standby conditions (e.g. 30 minutes after standby mode has been entered) and anyway before entering low power mode (if available), the receiver has to search for new software;
- if receiver is switched on while new software search has already started the update procedure will be aborted
- if receiver is switched on after new software has been found and download or upgrade is ongoing, the update procedure will be duly completed (loader progress messages should help user understanding what's going on)

b) If the "automatic software update in operate mode" option is available and set to "YES", then:

- at the specified time and with the specified frequency, if the receiver is on it has to search for new software;
- at the time the procedure is started, a 30 seconds countdown will appear on screen with the following message: "The receiver will start looking for new software in … seconds". Italian translation: "Il Box Interattivo comincerà la ricerca d'aggiornamenti software entro … secondi".
- The user will be able to press "OK" for letting the procedure start immediately or "exit" for aborting the procedure. In case the user will choose "exit", the procedure will be aborted and will not be performed again until the next scheduled time.

7. When new software has been installed, then (after the receiver has been automatically rebooted, if necessary, and switched on if it was in standby) a message like the following shall appear on screen: "Your receiver was successfully upgraded. New features are now available." (Italian Translation: "Il Box interattivo è stato aggiornato. Nuove funzionalità sono state aggiunte"). A further message could be displayed briefly describing what functionalities were added to the receiver. This message is up to the manufacturer and is intended for informing the user on what features were added on the receiver. This additional message is not mandatory, but it is strongly recommended. This message will even contain the manufacturer's call centre telephone number (if any) or, at least, a web site where finding the description of such new functionalities.
8. If new software is found and installed the message described above should be displayed and the automatic channel list updating procedure should be skipped. It is absolutely mandatory that the message described above is seen by the viewer.
9. The message will stay on the screen until the viewer presses the OK key.
10. It is strongly recommended that, within the receiver menu, a section is provided for describing the new features of the last downloaded software.

| N. | Settings / Italian Translation | Mandatory default settings |
|---|---|---|
| 1 | "Automatic software upgrade in stand by" / "Aggiornamento automatico del software con Televisore in standby". | YES / SI |
| 2 | "Automatic software upgrade in operate mode" / "Aggiornamento automatico del software con Televisore acceso". | YES / SI (if available) |
| 3 | "Time" / "Ora" | **04:00** AM |
| 4 | "Frequency" / "Frequenza" | "Daily" / "Quotidiana" = default ("Weekly" / "Settimanale" – other option possible) |

Table 33: Default settings for auto software upgrade

### *9.4.2. System Software Update*

Taking into account on one hand the increasing scarcity and expensiveness of broadcast capacity and on the other hand the huge size of modern receivers' software images (1GB+ on some TV sets), Over The Air (OTA) System Software Update (SSU) of installed receivers

is not always viable: in fact, a 100MB image would take more than 2 hours to download using 100kbit/s bandwidth, the maximum value that broadcasters can reasonably afford. For this reason:

- receivers with software images up to 100MB SHALL support the DVB System Software Update (DVB-SSU) specification as defined in [24], using the Simple Profile of DVB Data Downloading as defined in [23]. Receivers SHALL be able to find out their own DVB-SSU files without relying on the relevant linkage_descriptor in NIT or BAT.
- receivers with software images larger than 100MB SHALL support DVB-SSU notifications of updates made available for download over the Internet, as specified in latest DVB-SSU versions [24]. Thanks to DVB SSU Notifications receivers not connected to the internet could be informed that an update is available and then prompt the user to connect it, if possible, so that it can retrieve and download the update.
- receivers with software images larger than 100MB MAY support DVB-SSU using the Simple Profile of DVB Data Downloading as defined in [23].

Manufacturers SHALL provide appropriate recovery measures to cope with possible receiver failure or hang-up during the System Software Update.

# 10. Accessories and Setup

Receivers must be both easy to install and use. An existing viewer of analogue services needs to be able to complete a basic digital installation, i.e. just for viewing, using only what has been supplied with the receiver. In addition, on-screen information must be provided in a clear and consistent manner both to aid installation and (if required) to enable an easy dialogue with any support staff, e.g. call-centre

## 10.1. Receiver Accessories

The manual should contain at least the following information:

- Advice on the verification and eventual adaptation of reception equipment
- The modes of connection of other peripheral appliances (TV, VCR, DVD, other STB)
- Mode of connection to the broadband network
- Set up and tuning of the receiver
- Description of the functions of the remote control keys
- Options and accessories (e.g. Infra-red Keyboard, etc…)
- Troubleshooting
- Information on a call centre number to resolve connection problems.

| Accessory | Presence |
|---|---|
| 1 Power Cable | Mandatory |
| Handbook in Italian language | Mandatory |

Table 34: Accessories

## 10.2. Power Supply / Voltage

220V AC + 15%; 50 + 2 Hz (Low Voltage recommendation 73/23/CEE e 93/68/CEE. Law n° 971/1977).

## 10.3. Low-power mode

In order for receivers supporting a low-power standby feature, based on mandatory or voluntary EU ecodesign requirements, to meet operators' needs (e.g. rights refresh for Pay TV services, spot software upgrade campaigns), the following recommendations/constraints apply:

1. It SHOULD be possible disabling/enabling low-power standby mode through a dedicated menu option
2. before entering low-power standby mode receivers SHALL perform, if currently enabled, automatic channel list update and software upgrade
3. transition from normal to low-power stand-by mode SHOULD take at least 1 hour
4. low-power standby mode SHOULD NOT last longer than 23 consecutive hours before normal stand-by is entered; after house keeping (point 2) is performed and proper transition time waited (point 3), low-power standby mode will be entered again.

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# 11. Default settings

The following is a list of the overall default settings of the receiver. These requirements are intended to provide to all receivers on the market a very similar behaviour when they are installed or restored to factory defaults.
Those strictly related to broadcasters' services and applications (Application Autostart, Parental Control, Automatic OTA Update, Automatic Channel Update, LCN) shall be compliant with the table below. The rest should be considered by manufacturers just as a suggestion.

| Feature | Specification | Status | Note |
|---|---|---|---|
| **Auto-start Application** | Default option (if any) should be "YES" | Mandatory | When application autostart is ON, progress loading bars or other icons SHALL NOT be displayed while applications are being loaded or started. *This provision doesn't apply to applications signalled in AIT file.* Such icons SHALL instead be displayed in case application autostart has been switched OFF by the customer. |
| | | | |
| **Present and Next banner** | | | |
| • Duration | Less or equal to 4 sec. | Mandatory | |
| • Current Time | Active | Optional | |
| • Channel number | Active | Mandatory | |
| • Service name | Active | Mandatory | Long "channel name" label |
| • Volume indicator | Active | Optional | If the receiver allows to locally control volume, the volume bar shall be present |
| | | | |
| **Country** | As per after the first installation | Mandatory | After first installation the default country shall be Italy |
| | | | |
| **Language options** | | | |
| • Language | As per after the first installation | Mandatory | After first installation the default language shall be Italian |
| • Primary Audio | As per after the first installation | Mandatory | |
| • Subtitles | Not Active | Mandatory | |
| • Primary Subtitles language | As per after the first installation | Mandatory | |
| | | | |
| **Automatic Channel Numbering** | Active | Mandatory | This is a toggle active/inactive |
| | | | |

| Feature | Specification | Status | Note |
|---|---|---|---|
| **TV settings** | | | |
| • Screen Format | 16:9 | Mandatory | |
| • HDMI output format | As per after the first installation | Mandatory | |
| • TV SCART output | RGB | Mandatory | |
| • VCR SCART output | CVBS | Mandatory | when available |
| • 3D Display | Y/N | Mandatory | Information gathered from HDMI VSDB overrides any manual setting |
| **Parental Control settings** | | | |
| PIN protected events | PIN shall be asked for any event with rating value equal or greater than 18 years | Mandatory | |
| **Automatic software upgrade** | | | |
| In Stand by mode | Active* | Mandatory | |
| In Operate mode | Active* | Optional | |
| Time | 4:00 am | Mandatory | |
| Repetition | Daily | Mandatory | |
| **Automatic channel list update** | | | |
| ..in Stand by mode | Active | Mandatory | |
| ..in Operate mode | Not Active | Optional | |
| Time | 4:30 am | Mandatory | |
| Repetition | Daily | Mandatory | |

Table 35: Default settings summary table

* The automatic software upgrade shall be ON to avoid users missing the necessary upgrades. However, if an automatic upgrade feature is present, this must be clearly indicated to the user so that, at set up, he/she may choose to deactivate it. In that case, the information on availability of new software for the receiver shall be presented to the user.

# Annexes

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# A DVB-T2 Performance Tables[16]

## A.1 FEF and Auxiliary streams

To test that FEFs do not cause malfunctions the following T2+FEF test signal shall be generated and input to the receiver, with FEF power same as T2 signal and no added noise. The receiver should be able to receive this signal with no errors in the displayed video for PLP#0.

| *Property* | *Value* |
|---|---|
| ***Overall*** | |
| FFTSIZE | 32k |
| GI | 1/16 |
| Lf | 62 |
| SISO/MISO | SISO |
| PAPR | TR-PAPR |
| Frames per superframe ($N_{T2}$) | 6 |
| Bandwidth | 8MHz |
| Extended Bandwidth Mode | Yes |
| Pilot Pattern | PP4 |
| L1 Modulation | 64QAM |
| FEF Type | 0 |
| FEF Length (samples) | 588000 |
| FEF Interval | 6 |
| FEF P1: S1 Value | 2 |
| FEF P1: S2 Value | 1 |
| L1 Repetition | 0 |
| ***PLP #0*** | |
| Type | 1 |
| Modulation | 256QAM |
| Rate | 3/5 |
| FEC Type | 64800 |
| Rotated QAM | Yes |
| FEC blocks per interleaving frame | 200 |
| TI blocks per frame (N_TI) | 3 |
| T2 frames per Interleaving Frame (P_I) | 1 |
| Frame Interval (I_JUMP) | 1 |
| Type of time-interleaving | 0 |
| Time Interleaving length | 3 |

Table 36: FEF test signal

To test that the presence of Auxiliary streams does not cause malfunctions the following test signal shall be generated and input to the receiver, with no added noise. The receiver, with Auxiliary streams enabled, should be able to receive this signal with no errors in the displayed video for PLP#0.

[16] All data specified in this Annex are preliminary because DVB-T2 experience in real operations is very limited, especially in case of SFN

| Property | Value |
|---|---|
| ***Overall*** | |
| FFTSIZE | 32k |
| GI | 1/16 |
| Lf | 62 |
| SISO/MISO | SISO |
| PAPR | TR-PAPR |
| Frames per superframe ($N_{T2}$) | 6 |
| Bandwidth | 8MHz |
| Extended Bandwidth Mode | Yes |
| Pilot Pattern | PP4 |
| L1 Modulation | 64QAM |
| FEFs | Not used |
| L1 Repetition | 0 |
| ***PLP #0*** | |
| Type | 1 |
| Modulation | 256QAM |
| Rate | 3/5 |
| FEC Type | 64800 |
| Rotated QAM | Yes |
| FEC blocks per interleaving frame | 200 |
| TI blocks per frame (N_TI) | 3 |
| T2 frames per Interleaving Frame (P_I) | 1 |
| Frame Interval (I_JUMP) | 1 |
| Type of time-interleaving | 0 |
| Time Interleaving length | 3 |

Table 37: Auxiliary streams test signal

## A.2 C/N Performance

Examples of C/N values and sensitivity are given in the following tables.

AWGN and “0dB echo” C/N calculations are based on NorDig [78] and EBU [76] assumptions for implementation losses.

Ricean and Rayleigh C/N calculations are based on EBU assumptions [76].

| Modulation | Code rate | C/N performance (dB) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 32KE PP2 C/N (dB) | | | | 32KE PP2 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc | | | |
| | | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayleigh) P1 | Profile4 (0dB echo) | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayleigh) P1 | Profile4 (0dB echo) |
| QPSK | 1/2 | 3.5 | 3.7 | 4.5 | 5.2 | -95.6 | -95.4 | -94.6 | -93.9 |
| QPSK | 3/5 | 4.7 | 4.9 | 6.0 | 6.8 | -94.4 | -94.2 | -93.1 | -92.3 |
| QPSK | 2/3 | 5.6 | 5.9 | 7.4 | 8.4 | -93.5 | -93.2 | -91.7 | -90.7 |
| QPSK | 3/4 | 6.6 | 6.9 | 8.7 | 9.8 | -92.5 | -92.2 | -90.4 | -89.3 |
| QPSK | 4/5 | 7.2 | 7.6 | 9.6 | 10.9 | -91.9 | -91.5 | -89.5 | -88.2 |
| QPSK | 5/6 | 7.7 | 8.1 | 10.4 | 12.0 | -91.4 | -91.0 | -88.7 | -87.1 |
| 16 QAM | 1/2 | 8.7 | 8.9 | 10.2 | 10.9 | -90.4 | -90.2 | -88.9 | -88.2 |
| 16 QAM | 3/5 | 10.1 | 10.3 | 11.8 | 12.7 | -89.0 | -88.8 | -87.3 | -86.4 |
| 16 QAM | 2/3 | 11.4 | 11.6 | 13.3 | 14.3 | -87.7 | -87.5 | -85.8 | -84.7 |
| 16 QAM | 3/4 | 12.5 | 12.9 | 14.9 | 16.3 | -86.6 | -86.2 | -84.1 | -82.8 |

| Modulation | Code rate | C/N performance (dB) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 32KE PP2 C/N (dB) | | | | 32KE PP2 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc | | | |
| | | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayleigh) P1 | Profile4 (0dB echo) | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayleigh) P1 | Profile4 (0dB echo) |
| 16 QAM | 4/5 | 13.3 | 13.7 | 16.2 | 17.8 | -85.8 | -85.4 | -82.9 | -81.3 |
| 16 QAM | 5/6 | 13.8 | 14.2 | 17.0 | 18.9 | -85.3 | -84.8 | -82.1 | -80.1 |
| 64QAM | 1/2 | 13.0 | 13.3 | 15.0 | 16.0 | -86.1 | -85.8 | -84.0 | -83.1 |
| 64QAM | 3/5 | 14.8 | 15.1 | 16.9 | 18.0 | -84.2 | -83.9 | -82.2 | -81.1 |
| 64QAM | 2/3 | 16.2 | 16.5 | 18.3 | 19.7 | -82.9 | -82.6 | -80.8 | -79.4 |
| 64QAM | 3/4 | 17.7 | 18.0 | 20.4 | 22.0 | -81.4 | -81.1 | -78.7 | -77.1 |
| 64QAM | 4/5 | 18.7 | 19.2 | 22.0 | 24.0 | -80.3 | -79.8 | -77.1 | -75.1 |
| 64QAM | 5/6 | 19.4 | 19.8 | 23.0 | 25.5 | -79.7 | -79.3 | -76.1 | -73.6 |
| 256 QAM | 1/2 | 17.0 | 17.4 | 19.5 | 20.6 | -82.1 | -81.7 | -79.6 | -78.5 |
| 256 QAM | 3/5 | 19.4 | 19.6 | 21.7 | 23.1 | -79.7 | -79.5 | -77.4 | -76.0 |
| 256 QAM | 2/3 | 20.8 | 21.1 | 23.3 | 25.1 | -78.2 | -77.9 | -75.8 | -73.9 |
| 256 QAM | 3/4 | 22.9 | 23.2 | 25.8 | 28.0 | -76.2 | -75.9 | -73.2 | -71.1 |
| 256 QAM | 4/5 | 24.3 | 24.8 | 28.0 | 30.8 | -74.8 | -74.3 | -71.1 | -68.2 |
| 256 QAM | 5/6 | 25.1 | 25.6 | 29.5 | 33.6 | -73.9 | -73.5 | -69.6 | -65.5 |

Table 38: Example of maximum required C/N and sensitivity for QEF reception at TS output (PP2 and FFT size 32KE)

| Modulation | Code rate | C/N performance (dB) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 32KE PP4 C/N (dB) | | | | 32KE PP4 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc | | | |
| | | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayleigh) P1 | Profile4 (0dB echo) | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayeigh) P1 | Profile4 (0dB echo) |
| QPSK | 1/2 | 3.1 | 3.3 | 4.1 | 4.8 | -96.0 | -95.8 | -95.0 | -94.3 |
| QPSK | 3/5 | 4.3 | 4.5 | 5.6 | 6.4 | -94.8 | -94.6 | -93.5 | -92.7 |
| QPSK | 2/3 | 5.2 | 5.5 | 7.0 | 8.0 | -93.9 | -93.6 | -92.1 | -91.1 |
| QPSK | 3/4 | 6.2 | 6.5 | 8.3 | 9.4 | -92.9 | -92.6 | -90.8 | -89.7 |
| QPSK | 4/5 | 6.8 | 7.2 | 9.2 | 10.5 | -92.3 | -91.9 | -89.9 | -88.6 |
| QPSK | 5/6 | 7.3 | 7.7 | 10.0 | 11.6 | -91.8 | -91.4 | -89.1 | -87.5 |
| 16 QAM | 1/2 | 8.3 | 8.5 | 9.8 | 10.5 | -90.8 | -90.6 | -89.3 | -88.6 |
| 16 QAM | 3/5 | 9.7 | 9.9 | 11.4 | 12.3 | -89.4 | -89.2 | -87.7 | -86.8 |
| 16 QAM | 2/3 | 11.0 | 11.2 | 12.9 | 13.9 | -88.1 | -87.9 | -86.2 | -85.2 |
| 16 QAM | 3/4 | 12.1 | 12.5 | 14.5 | 15.8 | -87.0 | -86.6 | -84.6 | -83.2 |
| 16 QAM | 4/5 | 12.9 | 13.3 | 15.7 | 17.4 | -86.2 | -85.8 | -83.3 | -81.7 |
| 16 QAM | 5/6 | 13.4 | 13.8 | 16.5 | 18.5 | -85.7 | -85.3 | -82.5 | -80.6 |
| 64QAM | 1/2 | 12.6 | 12.9 | 14.6 | 15.5 | -86.5 | -86.2 | -84.5 | -83.5 |
| 64QAM | 3/5 | 14.4 | 14.7 | 16.4 | 17.6 | -84.7 | -84.4 | -82.6 | -81.5 |
| 64QAM | 2/3 | 15.7 | 16.0 | 17.9 | 19.2 | -83.3 | -83.0 | -81.2 | -79.8 |
| 64QAM | 3/4 | 17.3 | 17.6 | 20.0 | 21.6 | -81.8 | -81.5 | -79.1 | -77.5 |
| 64QAM | 4/5 | 18.3 | 18.8 | 21.6 | 23.5 | -80.8 | -80.3 | -77.5 | -75.6 |
| 64QAM | 5/6 | 18.9 | 19.3 | 22.5 | 25.0 | -80.2 | -79.7 | -76.6 | -74.1 |
| 256 QAM | 1/2 | 16.5 | 17.0 | 19.0 | 20.2 | -82.5 | -82.1 | -80.1 | -78.9 |
| 256 QAM | 3/5 | 18.9 | 19.1 | 21.2 | 22.6 | -80.2 | -79.9 | -77.8 | -76.4 |
| 256 QAM | 2/3 | 20.4 | 20.7 | 22.9 | 24.6 | -78.7 | -78.4 | -76.2 | -74.4 |
| 256 QAM | 3/4 | 22.4 | 22.7 | 25.3 | 27.4 | -76.7 | -76.3 | -73.7 | -71.7 |
| 256 QAM | 4/5 | 23.8 | 24.3 | 27.4 | 30.2 | -75.2 | -74.8 | -71.7 | -68.9 |
| 256 QAM | 5/6 | 24.6 | 25.1 | 28.9 | 32.7 | -74.4 | -74.0 | -70.2 | -66.3 |

Table 39: Example of maximum required C/N and sensitivity for QEF reception at TS output (PP4 and FFT size 32KE)

| Modulation | Code rate | C/N performance (dB) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 32KE PP4 C/N (dB) | | | | 32KE PP4 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc | | | |
| | | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayleigh) P1 | Profile4 (0dB echo) | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayeigh) P1 | Profile4 (0dB echo) |
| QPSK | 1/2 | 2.4 | 2.6 | 3.4 | 4.1 | -96.6 | -96.4 | -95.6 | -94.9 |
| QPSK | 3/5 | 3.6 | 3.8 | 4.9 | 5.7 | -95.4 | -95.2 | -94.1 | -93.3 |

| Modulation | Code rate | C/N performance (dB) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 32KE PP4 C/N (dB) | | | | 32KE PP4 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc | | | |
| | | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayleigh) P1 | Profile4 (0dB echo) | Profile1 Gaussian (AWGN) | Profile2 (Ricean) F1 | Profile3 (Rayeigh) P1 | Profile4 (0dB echo) |
| QPSK | 2/3 | 4.5 | 4.8 | 6.3 | 7.3 | -94.5 | -94.2 | -92.7 | -91.7 |
| QPSK | 3/4 | 5.5 | 5.8 | 7.6 | 8.7 | -93.5 | -93.2 | -91.4 | -90.3 |
| QPSK | 4/5 | 6.1 | 6.5 | 8.5 | 9.9 | -92.9 | -92.5 | -90.5 | -89.2 |
| QPSK | 5/6 | 6.6 | 7.0 | 9.3 | 11.0 | -92.4 | -92.0 | -89.7 | -88.1 |
| 16 QAM | 1/2 | 7.6 | 7.8 | 9.1 | 9.9 | -91.4 | -91.2 | -89.9 | -89.2 |
| 16 QAM | 3/5 | 9.0 | 9.2 | 10.8 | 11.7 | -90.0 | -89.8 | -88.3 | -87.4 |
| 16 QAM | 2/3 | 10.4 | 10.6 | 12.3 | 13.3 | -88.7 | -88.5 | -86.8 | -85.8 |
| 16 QAM | 3/4 | 11.5 | 11.9 | 13.9 | 15.2 | -87.6 | -87.2 | -85.2 | -83.9 |
| 16 QAM | 4/5 | 12.3 | 12.7 | 15.1 | 16.7 | -86.8 | -86.4 | -84.0 | -82.3 |
| 16 QAM | 5/6 | 12.8 | 13.2 | 15.9 | 17.9 | -86.3 | -85.9 | -83.2 | -81.2 |
| 64QAM | 1/2 | 12.0 | 12.3 | 14.0 | 14.9 | -87.1 | -86.8 | -85.1 | -84.2 |
| 64QAM | 3/5 | 13.8 | 14.1 | 15.8 | 16.9 | -85.3 | -85.0 | -83.3 | -82.1 |
| 64QAM | 2/3 | 15.1 | 15.4 | 17.2 | 18.6 | -84.0 | -83.7 | -81.8 | -80.5 |
| 64QAM | 3/4 | 16.6 | 16.9 | 19.3 | 20.9 | -82.4 | -82.1 | -79.8 | -78.2 |
| 64QAM | 4/5 | 17.7 | 18.2 | 20.9 | 22.8 | -81.4 | -80.9 | -78.2 | -76.2 |
| 64QAM | 5/6 | 18.3 | 18.7 | 21.9 | 24.3 | -80.8 | -80.4 | -77.2 | -74.8 |
| 256 QAM | 1/2 | 15.9 | 16.3 | 18.4 | 19.5 | -83.2 | -82.8 | -80.7 | -79.6 |
| 256 QAM | 3/5 | 18.3 | 18.5 | 20.6 | 22.0 | -80.8 | -80.6 | -78.5 | -77.1 |
| 256 QAM | 2/3 | 19.7 | 20.0 | 22.2 | 23.9 | -79.3 | -79.0 | -76.9 | -75.1 |
| 256 QAM | 3/4 | 21.7 | 22.1 | 24.6 | 26.6 | -77.3 | -77.0 | -74.5 | -72.4 |
| 256 QAM | 4/5 | 23.2 | 23.6 | 26.6 | 29.3 | -75.9 | -75.5 | -72.4 | -69.8 |
| 256 QAM | 5/6 | 23.9 | 24.4 | 28.0 | 31.6 | -75.1 | -74.7 | -71.0 | -67.5 |

Table 40: Example of maximum required C/N and sensitivity for QEF reception at TS output (PP7 and FFT size 32KE)

Note 1: Values do not include any possible additional Implementation Loss for Ricean (e.g. 0.5dB) and Rayleigh (e.g. 0.75dB) that can be adopted as “safety margin” for receiver conformance purposes only. It’s expected that this possible additional margin shall be included into the typical (e.g. 1 dB) “measurement error margin” that is always admitted for receiver conformance purposes.

Note 2: Values of Sensitivity are calculated under the assumption NF= 6dB

Note 3: Values of sensitivity for 32KN (8MHz BW) can be obtained taking into account the difference of the signal BW between the two cases (7.77 MHz vs. 7.61 MHz), giving for 32KN a reduction of approximately 0.1 dB with respect to the case of 32KE. Values of sensitivity in case of 7MHz BW can be obtained accordingly to the previous rule (6.80 MHz for 32KE and 6.66 MHz for 32KN) giving a value of approx. 0.6 dB less than the case of 8MHz BW.

Note 4: Receivers shall be capable of QEF reception for all the DVB-T2 possible modes (as from the list of “Mandatory requirement”) listed in this version of HD-Book. Additional values for the C/N Performance (e.g. valid for PP1) can be obtained using similar assumptions to those in [76] and [78].

Note 5: C/N values in the Tables can be used for 32KN FFT size and also for other FFT sizes e.g. 16K. Guard Interval does not influence C/N and, therefore, sensitivity.

Profile 1: Gaussian noise (N) is applied together with the wanted carrier (C) in a signal bandwidth of a DVB-T2 signal. No echo is applied.

Profile 2: The Ricean channel is defined according to the following table (derived from Table B.1 of [13]). Path #14 is omitted.

Profile 3: The Rayleigh channel definition is derived from the following table as well by removing path #0 and re-normalising amplitude values.

| # | normalised ρi [dB] | τi(μs) | θi(deg) |
|---|---|---|---|
| 0 | -0.4 | 0.000 | 0 |
| 1 | -24.0 | 0.074 | 122 |
| 2 | -27.5 | 0.144 | 226 |
| 3 | -36.8 | 0.154 | 63 |
| 4 | -27.5 | 0.194 | 198 |
| 5 | -26.4 | 0.204 | 63 |
| 6 | -21.6 | 0.430 | 340 |
| 7 | -18.8 | 0.519 | 336 |
| 8 | -22.8 | 0.603 | 215 |
| 9 | -24.1 | 0.641 | 191 |
| 10 | -22.6 | 0.849 | 36 |
| 11 | -23.4 | 0.924 | 210 |
| 12 | -35.8 | 1.003 | 278 |
| 13 | -35.2 | 1.017 | 311 |
| 14 | -22.7 | 1.369 | 23 |
| 15 | -29.7 | 1.381 | 162 |
| 16 | -19.0 | 1.936 | 9 |
| 17 | -21.4 | 2.752 | 127 |
| 18 | -20.1 | 3.229 | 175 |
| 19 | -25.7 | 3.325 | 331 |
| 20 | -26.1 | 5.422 | 196 |

Table 41: Ricean channel definition

Profile 4: The “0 dB echo” is the combination of two paths at the same level. The 0 degree channel center shall be used in fading simulator and attenuation 0dB for the second path with delay 1.95μs. In this context it means that the carriers from the direct and echo signal are cumulative and the output power of the simulator is the power sum of the two paths.

### *A.2.1 Behavior in presence of echoes inside the guard interval*

The receiver SHALL provide the reference BER (QEF) when the DVB-T2 channel contains two (or more) static paths with relative delay from 1 μs up to 95% of the guard interval length, independently of the relative amplitude and phases of the paths. No noise is added.

### *A.2.2 Behavior in presence of echoes outside the guard interval*

QEF reception SHALL be possible for 32k FFT modes with echo levels up to the values defined in the following tables (Echo attenuation in dB relative reference).

| Delay -/+ μs (8MHz channels) | 120 | 150 | 200 | 230 | 260 |
|---|---|---|---|---|---|
| Delay -/+ μs (7MHz channels) | 135 | 165 | 215 | 266 | 298 |
| 256QAM, PP4, GI 1/16, code 3/5 | - | - | - | 2.0 | 4.0 |
| 256QAM, PP4, GI 1/16, code 2/3 | - | - | - | 3.0 | 6.0 |
| 256QAM, PP4, GI 1/16, code 3/4 | - | - | - | 4.0 | 8.0 |
| 256QAM, PP4, GI 1/32, code 3/5 | 2.0 | 4.0 | 7.0 | 9.0 | 10.0 |
| 256QAM, PP4, GI 1/32, code 2/3 | 3.0 | 6.0 | 10.0 | 11.0 | 12.0 |
| 256QAM, PP4, GI 1/32, code 3/4 | 4.0 | 8.0 | 12.0 | 13.0 | 14.0 |

Table 42 QEF reception for echoes outside the guard interval for PP4

| Delay -/+ µs (7MHz channels) | 266 | 298 | 400 | 512 | 608 |
|---|---|---|---|---|---|
| 256QAM, PP2, GI 1/16, code 3/5 | 2.0 | 4.0 | 9.0 | 11.0 | 12.0 |
| 256QAM, PP2, GI 1/16, code 2/3 | 3.0 | 6.0 | 11.0 | 14.0 | 15.0 |
| 256QAM, PP2, GI 1/16, code 3/4 | 4.0 | 8.0 | 14.0 | 16.0 | 18.0 |

Table 43 QEF reception for echoes outside the guard interval for PP2, GI 1/16, 7MHz

| Delay -/+ µs (8MHz channels) | 120 | 150 | 200 | 230 | 260 |
|---|---|---|---|---|---|
| Delay -/+ µs (7MHz channels) | 135 | 165 | 215 | 266 | 298 |
| 256QAM, PP2, GI 1/8, code 3/5 | 3.5 | 5.5 | 7.0 | 8.0 | 8.5 |
| 256QAM, PP2, GI 1/8, code 2/3 | 5.0 | 7.0 | 8.5 | 9.5 | 10.0 |
| 256QAM, PP2, GI 1/8, code 3/4 | 7.0 | 9.0 | 10.5 | 11.5 | 12.0 |

Table 44 QEF reception for echoes outside the guard interval for PP2, GI 1/8

As a non-mandatory indication of typical receiver performance, QEF reception in case of three SFN static paths inside the guard interval and one SFN static path outside the guard interval should be possible for the T2 modes and echo profiles below:

- 8MHz, FFT 32K, 256QAM, CR 2/3, PP4, GI 1/16

| Path (tap) | Delay (µs) | Relative attenuation (dB) |
|---|---|---|
| 1 (useful) | 0 | 6 |
| 2 (useful) | 50 | 0 (reference -60 dBm) |
| 3 (useful) | 180 | 10 |
| 4 (interference) | 270 | 20.7 |

Table 45: Test set-up (PP4) for pre-echoes and echoes outside the guard interval (informative)

- 8MHz, FFT 32K, 256QAM, CR 2/3, PP2, GI 1/8

| Path (tap) | Delay (µs) | Relative attenuation (dB) |
|---|---|---|
| 1 (useful) | 0 | 6 |
| 2 (useful) | 50 | 0 (reference -60 dBm) |
| 3 (useful) | 180 | 10 |
| 4 (interference) | 550 | 21.1 |

Table 46: Test set-up (PP2) for pre-echoes and echoes outside the guard interval (informative)

### *A.2.3 Behavior in presence of co-channel interference*

QEF reception shall be possible in the presence of a DVB-T/T2 co-channel interferer with a C/I level according to column “C/N Ricean” (profile 2) in Table 48, Table 49 and Table 50 when the interference is uncorrelated with the wanted signal.

As a non-mandatory indication of typical receiver performance, in the case of a co-channel interference where the interferer may be correlated with the wanted DVB-T2 signal symbol timing and pilot pattern (e.g. inside an SFN), an additional margin of 1dB should be added.

### *A.2.4 Behavior in presence of digital signal in other channels*

Reference is the NorDig Unified specification ver. 2.5.1 [78], chapter 3.4.10.6.1 “Immunity to DVB-T/T2 signals in other channels”.

### *A.2.5 Behavior in presence of co-channel analogue signals*

Reference is the NorDig Unified ver. 2.4 [56], chapter 3.4.10.8 “Immunity to Co-Channel Interference from Analogue TV signals”.

The receiver shall perform better than specified in Table 53 when a 8MHz DVB-T2 signal is exposed to interference from a co-channel G/PAL signal including video with teletext, an FM sound and a NICAM sub carrier. The level of the FM sound relative to the vision carrier is -13 dB. The level of the NICAM signal relative to the vision carrier is -20 dB.

| Constellation | 256 QAM | | |
|---|---|---|---|
| Code rate | 3/5 | 2/3 | 3/4 |
| C/I | 3 dB | 5 dB | 7 dB |

Table 47 Carrier to Interference, C/I (dB) for QEF reception, when DVB-T2 signal is interfered with by an analogue TV carrier.

## A.3 List of some DVB-T2 modes for different types of networks and receiving conditions

Table 48 shows a list of suitable T2 modes for a number of different network configurations and receiving conditions. It represents only a small sample of all the T2 modes that are possible. The intent is to give some examples, without limiting the possibility to adopt different T2 modes.

Being the exact Bit-Rate of these modes subject to the choice of other parameters like, e.g., Lf and L1mod (and the combination of the PLPs in case of multiple PLP), all the values in the table are rounded and given only as an indicative value.

| Type | Very Large SFN | Very Large SFN | Large SFN-MISO | Large SFN | Local SFN | MFN | Portable | Mobile | Fixed/ Portable | Fixed/Mobile | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Single PLP | | | | | | | | Multiple PLP | T2 Base/Lite | |
| Examples | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| FFT | 32K | 32K | 32K | 32K | 32K | 32K | 16k | 16k | 32K | 32K | 8K |
| BW Extension (E/N) | E | N | E | E | E | N | E | E | E | E | N |
| GI | 1/8 | 1/8 | 19/256 | 1/16 | 1/32 | 1/128 | 1/4 | 1/4 | 1/8 | 1/16 | 1/4 |
| GI duration (µs) | 448 | 448 | 266 | 224 | 112 | 28 | 448 | 448 | 448 | 224 | 224 |
| PP | PP2 | PP2 | PP2 | PP4 | PP4 | PP7 | PP1 | PP1 | PP2 | PP4 | PP1 |
| PLP1 Modulation | 256QAM | 256QAM | 256QAM | 256QAM | 256QAM | 256QAM | 64QAM | 16QAM | 256QAM | 256QAM | QPSK |
| Rotation (R/NR) | R | NR | R | R | R | R | NR | R | R | R | R |
| PLP1 Code rate | 2/3 | ¾ | 2/3 | 2/3 | 2/3 | 3/5 | 3/4 | 1/2 | 3/4 | 3/4 | 2/3 |
| PLP2 Modulation | - | - | - | - | - | - | - | - | 16QAM | - | - |
| Rotation (R/NR) | - | - | - | - | - | - | - | - | R | | |
| PLP2 Code rate | - | - | - | - | - | - | - | - | 3/4 | - | - |
| SISO/MISO | SISO | SISO | MISO | SISO | SISO | SISO | SISO | SISO | SISO | SISO | SISO |
| T2-Base/Lite | T2-Base | T2-Base | T2-Base | T2-Base | T2-Base | T2-Base | T2-Base | T2-Base | T2-Base | T2-Base | T2-Lite |
| Bit-Rate (Mbit/s) | 33 | 36 | 34 | 36 | 38 | 35 | 25 | 11 | 33 | 28 | 1,9 |

Table 48: List of some DVB-T2 Modes

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# B DVB-T Minimum input level

QEF reception (BER 2E-4 after Viterbi) shall be possible with the minimum input levels in the table below for UHF Channels (8MHz BW), FFT 8k and GI 1/4.

Below table is based on the values in [78] (Table 3.14) and in [77] (Table 2.2).Values for “60s Error free video” are given as a suitable reference for measurement purposes. The description of the “60s Error free video” method is included in [77] at paragraph 2.3.2 (QEF Quality Measurement Methods).

The value for 64QAM 5/6 and the profile 4 (0 dB echo) for “60s Error free video”, is indicative only. It is an expected value for a typical DVB-T receiver.

Reference values for VHF channels (7 MHz BW) are those in [78] (Table 3.14) and [77] (Table 2.2).

| | | Minimum input level (dBm) | | | |
|---|---|---|---|---|---|
| | | Profile 1 Gaussian | | Profile 4 0 dB echo | |
| | | UHF Band IV & V 8 MHz signal | | UHF Band IV & V 8 MHz signal | |
| Modulation | Code rate | "60 s Error free video" | BER 2E-4 after Viterbi | "60 s Error Free video" | BER 2E-4 after Viterbi |
| QPSK | 1/2 | -94.4 | -93.1 | -90.6 | -89.4 |
| QPSK | 2/3 | -92.6 | -91.3 | -86.3 | -84.5 |
| QPSK | 3/4 | -91.6 | -90.3 | -84.1 | -80.8 |
| QPSK | 5/6 | -90.6 | -89.3 | - | - |
| QPSK | 7/8 | -89.8 | -88.5 | - | - |
| 16 QAM | 1/2 | -88.7 | -87.4 | -86.1 | -84.9 |
| 16 QAM | 2/3 | -86.4 | -85.1 | -81.9 | -80.3 |
| 16 QAM | 3/4 | -84.9 | -83.6 | -79.2 | -76.1 |
| 16 QAM | 5/6 | -83.9 | -82.6 | - | - |
| 16 QAM | 7/8 | -83.5 | -82.2 | - | - |
| 64 QAM | 1/2 | -83.0 | -81.7 | -80.4 | -79.2 |
| 64 QAM | 2/3 | -80.8 | -79.5 | -76.4 | -75.0 |
| 64 QAM | 3/4 | -79.3 | -78.0 | -73.4 | -70.6 |
| 64 QAM | 5/6 | -77.9 | -76.6 | -69.0 | - |
| 64 QAM | 7/8 | -77.0 | -75.7 | - | - |

Table 49: DVB-T minimum input levels (dBm)

Note: Values in above table are calculated under the assumption NF= 7dB.

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# C Behaviour of Player Pad keys for linear IP services

## C.1 Definitions

*In case of linear IP services (DASH live streaming using dynamic MPD [60]), the following definitions apply:*

- $T_0$: *Presentation time of the first segment made available on the server for this live content*
- $T_n$: *Presentation time of the segment associated with the client wall-clock time NOW*
- $T_x$: *Presentation time of the segment currently presented by the client. If no forward/backward skips were previously invoked by the user, $T_x$ is equal to $T_n$*
- $T_{0bd}$: *$T_n$ - `timeShiftBufferDepth`, i.e. presentation time of the first segment available on the server taking into account `timeShiftBufferDepth` parameter (if present in the MPD)*
- $T_{00}$: *$T_0$ if `timeShiftBufferDepth` is not present in the MPD or if it is present but ($T_n$ - $T_0$) < `timeShiftBufferDepth`, $T_{0bd}$ otherwise*
- S: *Amount of skip forward/backward time associated to a single FAST_FWD/REWIND key press. S=30s*
- $T_p$: *Presentation time of the segment being presented by the client when it executes a pause command*
- $T_r$: *Presentation time of the first segment presented by the client when it executes a resume command*
- $T_s$: *Presentation time of the first segment presented after a skip forward/backward command*

*As defined in DASH [60], Presentation time is the time associated to an access unit that maps it to the Media Presentation timeline.*

*DASH standard itself warns that a client not synchronized with a DASH server, which in turn is expected to be synchronized to UTC, may experience issues in accessing Segments as the Segment availability times provided by the server and the local time NOW may not be synchronized. Therefore, DASH clients are expected to synchronize their clocks to a globally accurate time standard.*

## C.2 Expected behaviour

*Player Pad keys, if present, should behave as follows:*

- *PAUSE key will pause presentation at time $T_p$*
- *PLAY key will resume presentation at time $T_r$=max($T_p$, $T_{00}$)*
- *FAST_FWD key will move presentation to $T_s$=max($T_x$ + S, $T_n$)*
- *REWIND key will move presentation to $T_s$=max($T_x$ - S, $T_{00}$)*

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# D Allocation and usage of SI codes in Italy

## D.1 Allocation of SI codes

As explained the Italian DTT environment is "*multi-network*" and "*multi-operator*". According to DVB SI Specification [10] and SI Guidelines [20]:

- a **network** is a collection of MPEG-2 Transport Stream (TS) multiplexes transmitted on a single delivery system (e.g. all digital channels on a specific cable or **terrestrial** system)
- a **service** is uniquely identified by the following parameters (the DVB locator):
  - **original_network_id (ON_ID):** unique identifier of a network
  - **transport_stream_id (TS_ID):** unique identifier of a TS within an original network.
  - **service_id (S_ID):** unique identifier of a service within a TS

The network_id (N_ID) is not part of this path.

The following figure shows the service delivery model for digital broadcasting:

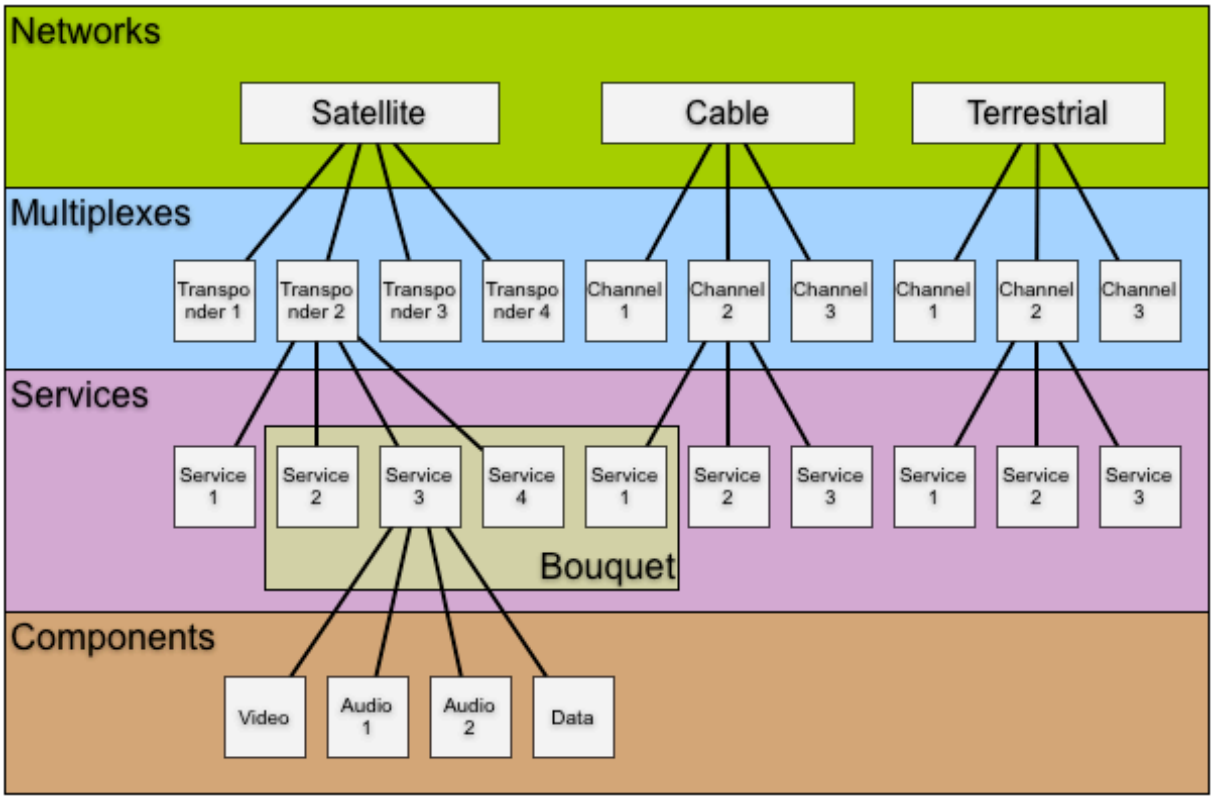


Figure 7: Service delivery model

The unique identification of a service cannot be guaranteed if each operator allocates these codes on arbitrary basis. A policy needs to be defined in order to avoid potential situations of conflict

## D.2 Original_network_id

Allocation of original_network_ids is presently handled by the DVB Project Office, on behalf of the ETSI.

The value of already pre-assigned ON_ID codes for terrestrial services is 0x2000 + 3-digit country code. Then for Italy the original_network_id value that should be allocated is: 0x217C (380dec - 0x17Chex is the country code for Italy).

The registration of this value shall be formally requested, by the competent authority to the DVB Project Office, in order to obtain afterwards the formal registration by ETSI in the Register of Service Information (SI) Codes.

It is recommended that all terrestrial operators in Italy use this value for ON_ID to avoid potential conflicts with other networks in the same area or in neighbouring countries.

Operators that have been allocated, by the DVB, a value for ON_ID and operators with services that originate from a satellite network may keep their allocated ON_ID or the ON_ID used on the satellite network.

## D.3 Transport_stream_id

The ON_ID value is not meant to be used to distinguish multiplexes of different operators.

Therefore, TS_ID and S_ID are the two parameters that are used to distinguish terrestrial multiplexes and services.

The Transport_Stream_ID has 65535 possible values (for each ON_ID): a unique value can be assigned to each and every national, regional or local multiplex. Every network operator shall be granted one or more values, as he requests and depending on the configuration of his network (number of transmitters).

### *D.3.1 Recommended allocation of codes*

DGTVi recommended the following allocation of codes:

| transport_stream_id | Use |
|---|---|
| 0x0000 | Reserved |
| 0x0001 – 0x03FF | Range usable for national networks (1023 values) |
| 0x0400 – 0x0FFF | Reserved for extension of national codes (3072 values) |
| 0x1000 – 0xB7FF | Range usable for regional/local networks (43008 values) |
| 0x1000 – 0x17FF | Region 1 (Piemonte) – 2048 values |
| 0x1800 – 0x1FFF | Region 2 (Valle d'Aosta) – 2048 values |
| 0x2000 – 0x27FF | Region 3 (Lombardia) – 2048 values |
| 0x2800 – 0x2FFF | Region 4 (Trentino) – 2048 values |
| 0x3000 – 0x37FF | Region 5 (Veneto) – 2048 values |
| 0x3800 – 0x3FFF | Region 6 (Friuli Venezia Giulia) – 2048 values |
| 0x4000 – 0x47FF | Region 7 (Liguria) – 2048 values |
| 0x4800 – 0x4FFF | Region 8 (Emilia Romagna) – 2048 values |
| 0x5000 – 0x57FF | Region 9 (Toscana) – 2048 values |
| 0x5800 – 0x5FFF | Region 10 (Umbria) – 2048 values |
| 0x6000 – 0x67FF | Region 11 (Marche) – 2048 values |
| 0x6800 – 0x6FFF | Region 12 (Lazio) – 2048 values |

| transport_stream_id | Use |
|---|---|
| 0x7000 – 0x77FF | Region 13 (Abruzzo) – 2048 values |
| 0x7800 – 0x7FFF | Region 14 (Molise) – 2048 values |
| 0x8000 – 0x87FF | Region 15 (Campania) – 2048 values |
| 0x8800 – 0x8FFF | Region 16 (Puglia) – 2048 values |
| 0x9000 – 0x97FF | Region 17 (Basilicata) – 2048 values |
| 0x9800 – 0x9FFF | Region 18 (Calabria) – 2048 values |
| 0xA000 – 0xA7FF | Region 19 (Sicilia) – 2048 values |
| 0xA800 – 0xAFFF | Region 20 (Sardegna) – 2048 values |
| 0xB000 – 0xB7FF | Reserved for future use |

Table 50: Allocation of TS_IDs in Italy

### *D.3.2 National Codes already in use*

Following codes are compatible with the recommended allocation.

| transport_stream_id | Operator |
|---|---|
| 0x0001 | Rai |
| 0x0002 | Rai |
| 0x0003 | Rai |
| 0x0004 | Rai |
| 0x0005 | Rai |
| 0x0006 | Rai |
| 0x0009 | Rai |
| 0x0200 | Persidera |
| 0x0201 | Persidera |
| 0x0202 | Persidera |
| 0x0204 | Persidera |
| 0x032A | H3G |
| 0x0384 | D-Free |
| 0x0385 | Mediaset |
| 0x0389 | Mediaset |
| 0x03A2 | Mediaset |
| 0x03AC | Mediaset |
| 0x03B6 | Mediaset |

Table 51: National TS_IDs in use

## D.4 Service_id

Because of the uniqueness of TS_ID assigned to every multiplex, the allocation of Service_IDs (65535 possible values) can be left to each multiplex operator. Receivers shall distinguish services with the same service_id (and ON_ID) but different TS_ID.

## D.5 Network_id

The DVB *network_id* is defined by ETSI TR 101 162 [19] which allocates the identifiers on a geographical basis to ensure that no conflict in adjacent network identities occurs in

different geographic regions. The allocation is typically referred to as the DVB color map as shown in the following figure.

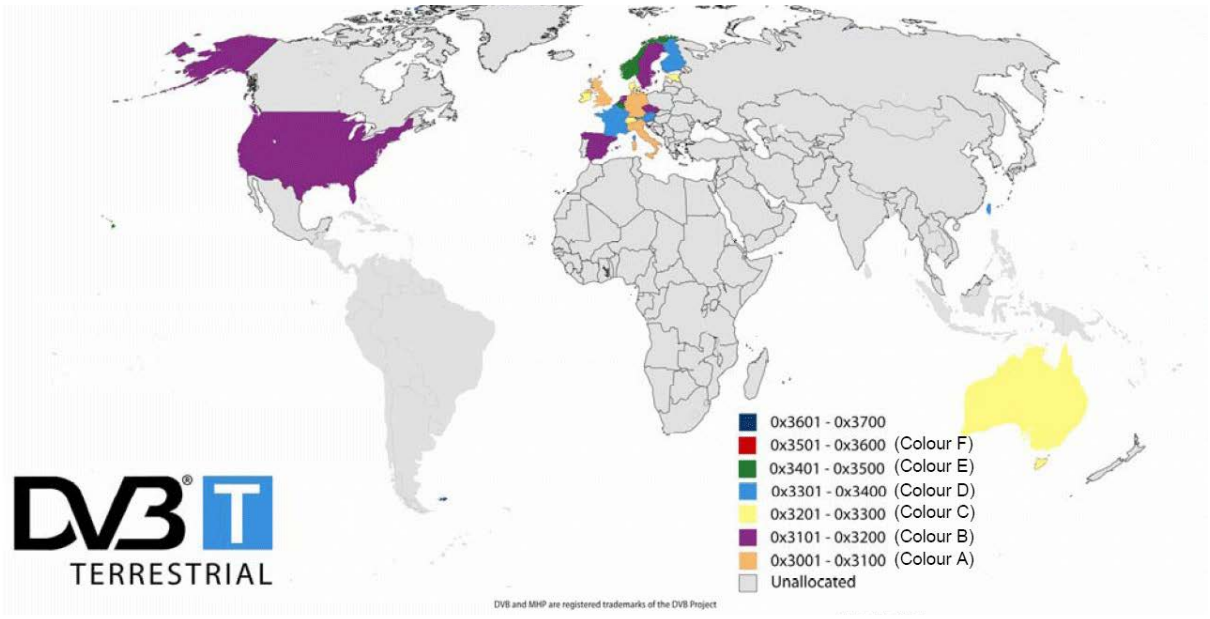


Figure 8: Colour map for allocating network_ids in terrestrial networks

The allocation of the network_id for countries in the European region comprising Italy is shown in the following table:

| Country | network_id |
|---|---|
| Austrian Digital Terrestrial Television | 0x3301 ÷ 0x3400 |
| French Digital Terrestrial Television | 0x3301 ÷ 0x3400 [17] |
| Italian Digital Terrestrial Television | 0x3001 ÷ 0x3100 |
| Slovenia Digital Terrestrial Television | 0x3201 ÷ 0x3300 |
| Spanish Digital Terrestrial Television | 0x3101 ÷ 0x3200 |
| Swiss Digital Terrestrial Television | 0x3201 ÷ 0x3300 |

Table 52: Network_ids of interest

Network_ids shall not be used to uniquely identify a service.

Network_ids shall instead be used to identify the country which a network belongs to for the purpose of LCN conflicts (see §7.3.2.5). In particular, if Italy has been selected as “Country” at first installation time, all networks whose network_id fits in the 0x3001÷0x3100 range shall be considered as belonging to Italy.

## D.6 Network Name

No assumption is or shall be made for this parameter.

[17] France will likely go on using as single network_id for the whole country the same value assigned by DVB to French DTT as original_network_id (0x20FA)

# E 2D service compatibility within 3DTV

## E.1 Introduction

*Starting from the work done in DVB (Annexes B of Parts 2 and 4 of [57]), this Annex provides implementation guidelines on possible modes of operation of frame compatible plano-stereoscopic 3DTV services that provide service compatible operation with 2D (HDTV) services under certain conditions. This kind of service backward compatibility is enabled by the HDTV decoder capability of extracting one of the frame-packed views of the frame compatible plano-stereoscopic 3DTV service video stream, and up-scaling it to simulate the reception of an HDTV service.*

*When using H.264/AVC, two video layer signalling fields are used for this purpose [58]:*

- *Cropping Rectangle which describes the active part of a decoded picture;*
- *Sample Aspect Ratio (SAR) within the Video Usability Information (VUI) which provides the needed scaling to generate the output image.*

*When using HEVC, the VUI Default Display Window parameter is used for this purpose [9], indicating how to extract a 2D picture from a frame packing arrangement..*

*Such service compatible modes give service providers the chance to transmit a single service that provides both frame compatible plano-stereoscopic 3DTV video and reduced-resolution (halved) HDTV video concurrently, whereas normally HDTV coverage with the same source content would be provided with a separate dedicated HDTV service.*

## E.2 3DTV use cases

*The following figure depicts the predominant use cases for the reception of frame compatible plano-stereoscopic 3DTV services, and the co-existence of frame compatible plano-stereoscopic 3DTV compliant receivers with existing HDTV (i.e. non-3DTV) equipment, taking into account the various capabilities with respect to 3DTV and the different kind of receivers (e.g. STB or iDTV).*

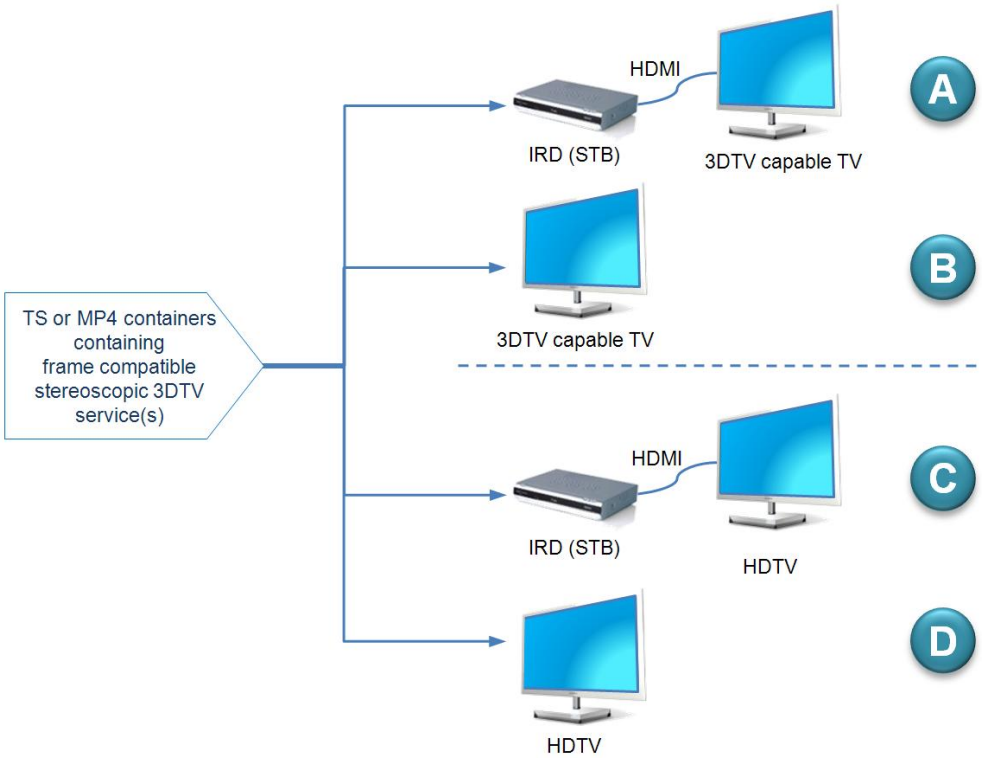


Figure 9: Frame compatible plano-stereoscopic 3DTV IRD use cases

***Legenda:***
***3DTV IRD use case A:*** *An IRD (STB) compliant with this specification is connected via HDMI to a 3DTV capable display device (qualified as such by the 3D_present flag being set to 1 in HDMI VSDB [53] or because manually set by the user). The user receives frame compatible 3DTV services via the STB.*
***3DTV IRD use case B:*** *A 3DTV IRD (iDTV) compliant with this specification receives frame compatible 3DTV services directly from the delivery channel.*
***3DTV IRD use case C:*** *An IRD (STB) compliant with this specification is connected via HDMI to a non-3DTV compliant HDTV set (or which doesn't qualify itself as such e.g. because 3D_present flag in HDMI VSDB is set to 0). Naturally, due to TV set limitation, it is not possible for the user to properly view the 3DTV services as in the 2 previous use cases but, thanks to this specification, he/she will be at least able to see them in 2D mode (halved HD resolution) if operators would transmit them in a 2D-compatible form.*
***3DTV IRD use case D:*** *An HDTV IRD (i.e. a non-3DTV compliant iDTV) compliant to this specification receives frame compatible 3DTV services directly from the delivery channel. Again, in this scenario it is not possible for the user to properly view the 3DTV services, but, thanks to this specification, he/she will be at least able to see them in 2D mode (halved HD resolution) if operators would transmit them in a 2D-compatible form.*

*Note that no additional PSI/SI signalling is needed, compared to that already defined for Frame Compatible and Service Frame Compatible Plano-stereoscopic 3DTV, in order to realize service compatibility for use cases C and D.*

## E.3 Implementation of 2D service compatibility with H.264/AVC video coding

*At H.264/AVC video layer signalling a 2D-compatible 3DTV signal will include the following information [58]:*
*- frame packing information within H.264/AVC SEI*
*- frame cropping information*
*- SAR information*

*To apply the cropping rectangle feature, the field frame_cropping_flag of the H.264/AVC seq_parameter_set_data() shall be set to '1'.*

*Table below provides the settings of frame cropping offsets and the sample aspect ratio for the frame compatible plano-stereoscopic 3DTV video formats that are suitable for application of this signalling[18]. Top-and-Bottom formats are not included and shall not be used with these service compatible modes, due to inherent limitations with the ability to perform vertical upscaling in many IRD implementations. The fields frame_crop_top_offset and frame_crop_bottom_offset take the same values as would be used for HDTV video.*

| Frame compatible plano-stereoscopic 3DTV video format | Frame crop left offset | Frame crop right offset | Sample aspect ratio |
|---|---|---|---|
| 1920 x 1080i Side-by-Side | 0 | 960 | 2:1 |
| 1280 x 720p Side-by-Side | 0 | 640 | 2:1 |

Table 53: H.264/AVC signalling for service compatible modes of frame compatible plano-stereoscopic 3DTV services

*In presence of 2D-compatible 3DTV signals, in the different use cases introduced above, IRDs SHALL behave as summarized in the following Table[19]:*

| Use cases | STB (if present) behaviour | TV behaviour |
|---|---|---|
| A | ▪ frame packing information is recognized within SEI and signalled over HDMI<br>▪ frame cropping offsets and sample aspect ratio combinations used for service compatible modes are ignored | ▪ frame packing information is recognized over HDMI and duly applied |
| B | | ▪ frame cropping offsets and sample aspect ratio combinations used for service compatible modes are ignored<br>▪ frame packing information is recognized within SEI and duly applied |
| C [20] | ▪ frame packing information within SEI is ignored<br>▪ frame cropping offsets and sample aspect ratio combinations used for service compatible modes are normally interpreted | ▪ full frame 2D signal received over HDMI is displayed |
| D | | ▪ frame packing information within SEI is ignored<br>▪ frame cropping offsets and sample aspect ratio combinations used for service compatible modes are normally interpreted<br>▪ full frame 2D signal is displayed |

Table 54: Expected IRD behaviour for 2D service compatible 3DTV transmissions

[18] *This signaling calls for cropping and up scaling capabilities of HDTV (i.e. non-3DTV cognizant) IRDs that exceed the minimum requirements currently defined by DVB in [9].*
[19] *Ignoring cropping and SAR information requires non-compliant H.264/AVC behaviour of frame compatible plano-stereoscopic 3DTV IRDs for the rendering of the 3DTV service. Such non-compliant behaviour might be overcome via suitable amendments of relevant specifications.*
[20] *An IRD (STB) compliant with this specification when connected via SCART to any TV set is expected to behave as in this use case, presenting on SCART the downscaled version of full frame 2D decoded signal*

*Above behavior is expected for both broadcast and broadband delivery of H.264/AVC 3DTV service components as well as for both the containers (TS and MP4) used for broadband delivery of H.264/AVC 3DTV service components.*

## E.4 Implementation of 2D service compatibility with HEVC video coding

*At HEVC video layer signalling a 2D-compatible 3DTV signal will include the following information [9]:*
*- frame packing information within HEVC SEI*
*- default display window*

*To apply the default display window feature, the field default_display_window_flag of the HEVC VUI shall be set to '1'.*

*Table below provides the settings of default display window offsets for the frame compatible plano-stereoscopic 3DTV video format.*

| Frame compatible plano-stereoscopic 3DTV video format | Default display window top offset (luma samples) | Default display window right offset (luma samples) | Default display window bottom offset (luma samples) | Default display window left offset (luma samples) |
|---|---|---|---|---|
| 1920 x 1080 Top and Bottom | 0 | 0 | 540 | 0 |

Table 55: HEVC signalling for service compatible modes of frame compatible plano-stereoscopic 3DTV services

*In presence of 2D-compatible 3DTV signals, in the different use cases introduced above, IRDs SHALL behave as summarized in the following Table:*

| Use cases | STB (if present) behaviour | TV behaviour |
|---|---|---|
| A | ▪ frame packing information is recognized within SEI and signalled over HDMI<br>▪ default display window offsets used for service compatible modes are ignored | ▪ frame packing information is recognized over HDMI and duly applied |
| B | | ▪ default display window offsets used for service compatible modes are ignored<br>▪ frame packing information is recognized within SEI and duly applied |
| C[21] | ▪ frame packing information within SEI is ignored<br>▪ default display window offsets used for service compatible modes are normally interpreted | ▪ full frame 2D signal received over HDMI is displayed |

[21] *An IRD (STB) compliant with this specification when connected via SCART to any TV set is expected to behave as in this use case, presenting on SCART the downscaled version of full frame 2D decoded signal*

| Use cases | STB (if present) behaviour | TV behaviour |
|---|---|---|
| D | | ▪ frame packing information within SEI is ignored<br>▪ default display window offsets used for service compatible modes are normally interpreted<br>▪ full frame 2D signal is displayed |

Table 56: Expected IRD behaviour for 2D service compatible 3DTV transmissions

*Above behavior is expected for both broadcast and broadband delivery of HEVC 3DTV service components as well as for both the containers (TS and MP4) used for broadband delivery of HEVC 3DTV service components.*

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***Printed in May 2016***
***by Meti S.a.s. (CS) - Italy***
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